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JOURNAL OF DAIRY SCIENCE

OFFICIAL ORGAN OF THE
AMERICAN DAIRY SCIENCE ASSOCIATION

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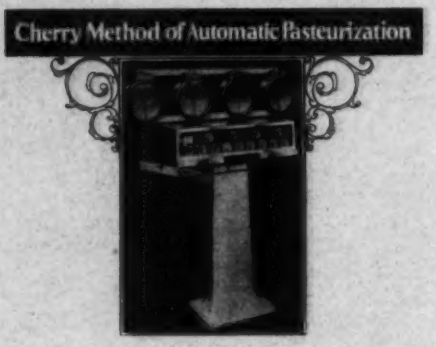

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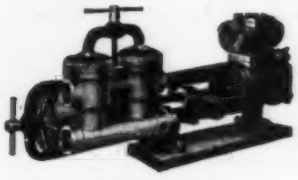

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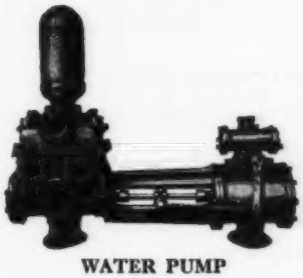

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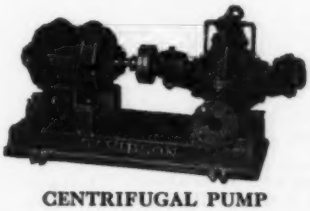

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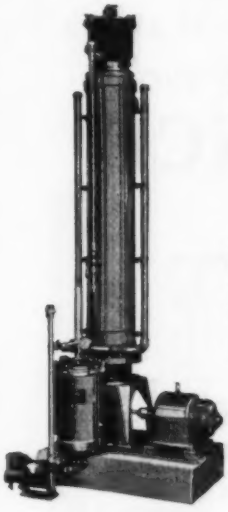

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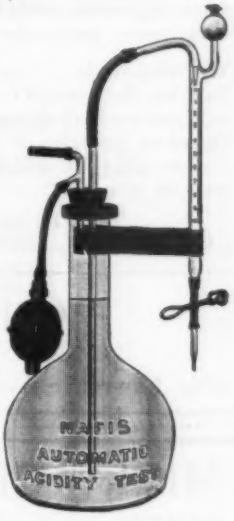

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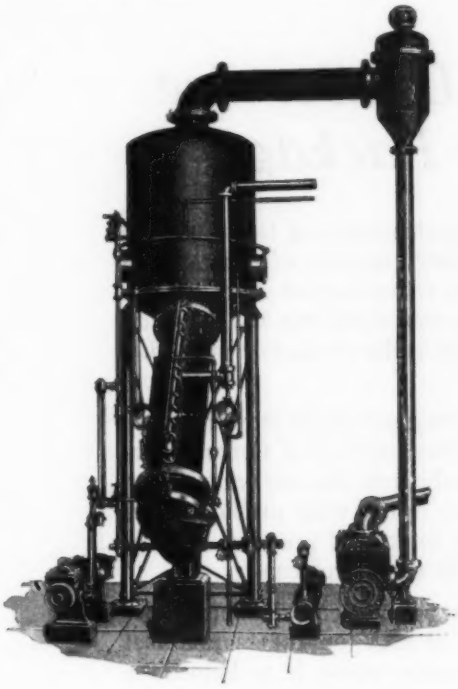

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Bernard H. Rawl

BERNARD H. RAWL

Bernard H. Rawl, who has been for many years one of the leading figures in the dairy industry in this country, died at Berkeley, Calif., September 23, 1924.

Mr. Rawl was born at Lexington, S. C., May 2, 1876. He was graduated from the Clemson Agricultural College in 1900, and, after graduate work in dairying and animal husbandry at the Pennsylvania State College and the University of Wisconsin, he returned to Clemson as assistant in the Dairy and Animal Husbandry Department. Upon the resignation of the professor in charge Mr. Rawl became the head of the Department.

In 1905 the Dairy Division of the United States Department of Agriculture began its work on the development of dairying in the South, and Mr. Rawl was placed in charge of this work. In 1909 he was made Chief of the Dairy Division, and in 1918 he became also Assistant Chief of the Bureau of Animal Industry. He filled both of these positions until 1921 when he resigned his position in the Department to become assistant general manager of the California Central Creameries, now the Golden State Milk Products Company, the position which he held at the time of his death.

In his organization of the work in dairying in the South he showed the foresight which was one of his most striking characteristics. He recognized the rights and responsibilities of the States in the development of the dairy industries within their borders, and made it plain that as the work developed and proved profitable, the States were gradually to relieve the Federal Department of Agriculture of direct supervision and expense. His wise leadership not only accomplished this result but developed a practical system of coöperation which has greatly facilitated the progress and development of dairying in the South. In addition to the work in dairying, he conceived and aided in establishing a plan of coöperation in agricultural extension work in South Carolina by that State and the United States Depart-

ment of Agriculture which eliminated duplication of work by these two agencies. This plan has since then been adopted by many, if not all, of the States.

Under Mr. Rawl's leadership as Chief the work of the Dairy Division was greatly extended. The Beltsville farm was acquired and provided with a herd, buildings, and equipment for the study of dairy herd management and problems in nutrition, milk secretion and breeding. The Experimental Creamery at Grove City, Pennsylvania, was established to provide opportunities for factory applications of methods developed in the laboratories and for the study of problems in factory management. The Western Office of the Dairy Division was established to obtain closer contact with dairying in the Western States, and dairy farming investigations were begun on the Department's farms in the semi-arid regions.

Mr. Rawl had an appreciation of the value of scientific research which is unusual in one whose daily work brought him in such close contact with the practical problems of the industry. In this appreciation he included the abstract laboratory problems as well as those relating more directly to the farm and the factory. As Chief of the Dairy Division he greatly strengthened and amplified the research work. He was especially interested in developing investigations in the nutrition and the breeding of dairy animals and the work which the Bureau of Dairying is now doing on these subjects is the direct result of his efforts. His interest in the Dairy Division did not cease when he severed his official connection with the Department. The success of the movement which resulted in the creation of a Bureau of Dairying was in a large measure due to his active interest.

Mr. Rawl's character was a mixture of strongly marked and contrasting traits. Fundamentally active and vigorous, he inspired his associates with his own high ideals of service to the public. Through his sympathetic interest in the efforts and the difficulties of others he produced about him an atmosphere of friendliness and comradeship. Outspoken in denunciation of poor work he was equally free in commendation of conscientious effort, maintaining that the one could not justly be given without

the other. Thoroughly democratic in all his instincts and habits he was always ready to extend to his associates constructive and sympathetic suggestions and criticisms and to aid them in finding the places best suited to their capabilities.

While taking his duties seriously and soberly, he had an unfailing sense of humor which carried him and his fellow workers through many difficult situations. To him problems were opportunities and obstacles inspired him to renewed effort. In his work as an executive he made decisions only after careful investigation and consideration, but having decided he acted with promptness and energy. All his work was marked by keen insight, a vision of the future, and by subordination of self.

Some of the more important agricultural movements now in progress owe their inception to his efforts although his part is known only to those who have been nearest him.

In his untimely death the dairy industry has lost a leader who had a comprehensive knowledge of its problems; who saw clearly and spoke forcefully; who stood always for the strictest integrity and the highest ideals. The noble personality of Bernard H. Rawl will always remain vivid in the minds of those who knew and loved him. The influence of the wholesome and intelligent service which he rendered the dairy industry will continue long after his friends and associates have passed away.

RESEARCH WORK OF THE BUREAU OF DAIRYING[1]

L. A. ROGERS

In Charge, Research Laboratories, Bureau of Dairying, U. S. D. A.

The subject assigned to me for discussion at this meeting of the Dairy Science Association is the research work in the Bureau of Dairying, but I feel that I can use your time to better advantage if I discuss the general question of research work in dairying. If I draw on the work of the Bureau for examples of how I think research work should or should not be done perhaps I will come sufficiently within the limits of my title.

The greater part of the investigational work in dairying is done with public funds and the public has a right to expect that this work will be so organized and conducted that the greatest possible returns will be secured. The public is much inclined to ignore purely scientific facts and to consider as returns from research only those advances which tend to increase the profits of industry. It behooves us, therefore, not only to obtain results of value but to coördinate our efforts so that these results will become applicable to the industry and available to the public. The organization of the research work of the Bureau of Dairying is a gradual development resulting from an attempt to meet this need.

I think I may assume that we are agreed that the progress of investigation in dairying has lagged behind that of other industries, and even behind some of the other branches of agriculture. I think you will also agree that the reason for this is the fact that in the early days research as well as instruction was left very largely to men trained in the art of dairying, but without any adequate knowledge of the basic science on which the art rests. It was inevitable that the work of these men should have been directed toward the perfection of the art

[1] Address delivered at Annual Meeting American Dairy Science Association, Milwaukee, Wisconsin, September 29, 1924.

rather than toward the development of a scientific basis for future progress.

Research workers are the product of institutions having outstanding leaders in research work and centers for dairy research are not yet sufficiently well established to develop a very large second crop of investigators.

There has been a very distinct progress, but in a large measure this has been due to the efforts of inventors rather than to organized research. One has but to consider the development of condensed and evaporated milk, milk powder and ice cream, the revolutionary changes in the butter industry brought about by the invention of the centrifugal cream separator, and the changes in machinery for handling milk and for manufacturing all types of dairy products to realize the correctness of this statement. In contrast to the work of these inventors we have some notable exceptions in men like Pasteur, Storch and Babcock whose far-reaching contributions were the result of systematic research designed for the benefit of the public.

We must admit, however, that until comparatively recent years we have been dependent for our advancement on the fortuitous results of inventors working for their personal benefit, and that many of those holding positions requiring investigation and teaching in dairying were inadequately trained in the basic sciences.

The name of the association under whose auspices we are meeting assumes that there is a science of dairying, but it would, I think, be more consistent to consider dairying as we consider medicine and agriculture in general, as an art to which many of the pure sciences are contributory. A man may be highly skilled in the art of dairying, with little knowledge of science, but a real understanding of the processes with which he is working is impossible without familiarity with the sciences of chemistry, physics, and bacteriology. Using the word SCIENCE in a broader sense we bring into our field such branches as physiology, genetics, anatomy and many others.

It is hardly necessary to urge upon this audience the necessity of the utilization of men trained in the basic sciences for investi-

gation of the problems of the dairy industry. Many of our problems, which superficially seem relatively simple, are in reality involved problems in physical or organic chemistry, requiring a familiarity with the most advanced chemical knowledge for their solution. Uncounted generations of dairymen have watched the globules of butter appear and grow in the churn, but a physical chemist of the first rank is required to determine the steps that bring about this redistribution of the various ingredients of the cream. The coagulation of milk by heat, rennet, or acid is even more complicated, involving a simultaneous reaction in several of the highly complex constituents of the milk. When we speculate on the process by which the cow converts the raw material of the feed into the casein, albumen and lactose of the milk with the reaction and the mineral salts carefully adjusted to maintain the colloids in suspension we hardly know where to begin an investigation. Problems of this nature require for their solution the best training obtainable. They can not be solved, as some institutions have seemed to assume, by dairy chemists whose technique is confined to the Babcock test and the Westphal balance. We must go, not to the institution turning out the greatest number of successful buttermakers and herdsmen, but to those colleges and universities where research work of the highest order is done. It is only in such environment that men equal to the solution of the scientific problems of dairying will develop.

In the usual course of events an investigation which has an application to an industrial process passes through three stages. The first of these is the acquisition of basic facts without relation to their possible application. In the second stage investigators, trained in the basic science involved and familiar with the processes of the industry, apply this new information to the improvement of old methods or to the development of new products. These first two steps are essentially laboratory problems. The third stage of the investigation is the application and adaptation of the laboratory results to the field or factory routine. These steps may be completed at widely separated places and with varying time intervals. The scientific investigation may not

come until the practice has been established for many generations and the results can be used only to explain what has already been developed by empirical methods. We are confronted at once with the question of the nature and the amount of work in what is usually called "pure science" which are justified in a dairy laboratory. Are we justified in using to any extent funds appropriated for investigations in dairying in carrying on problems which promise no immediate returns?

It is obvious that the basic information must be obtained by someone, somewhere. We can not build our house without a foundation and the laboratories devoted to dairy research should do their part in hewing the foundation stones. While it is futile to predict what information of value to practice may come from any fundamental investigation, the problems which a dairy laboratory should undertake may properly be limited to those sciences which have a more direct bearing on agriculture. The development of the X-ray may be traced directly to an investigation into the nature of electric discharges in high vacua. We have found the X-ray of value in studying structure of the udder and the development of eyes in Swiss cheese, but we would hardly feel justified in devoting our funds to a study of electric discharges. On the other hand, almost any chemical problem of a truly basic nature may lead to results having a direct bearing on some of our everyday problems.

Probably very few agricultural laboratories, even at the present time, would feel justified in undertaking the investigation of a problem like Pasteur's study of the tartaric acid crystals. The immediate results which he obtained, however great their interest to the chemist and crystallographer, were of no particular value to industry, but the discoveries to which this work led him have rehabilitated industries, revolutionized the practice of medicine, and founded a new science. An investigation designed to bring about these results could not have been planned at that time, because no one could have conceived the far reaching avenues opened by Pasteur's work.

While no one can predict the possible value of any investigations in pure science, nevertheless work in fundamental problems

of bacteriology, in the chemistry of the fats and the proteins, the laws of heredity, or the physics of heat transmission, is almost sure to bring results that have an application to some phase of the industry.

Some of these results find their application in the most unexpected places. An extensive investigation carried on in our laboratories on the relation of hydrogen ion concentration to the growth of bacteria not only greatly facilitated the study of many other problems, but also made it possible for another investigator to perfect a method for the production of citric acid by fermentation. A study of the lag period in bacterial growth has led to what is at least a good working hypothesis for the cause of nizzler Swiss cheese.

THE APPLICATION OF SCIENTIFIC FACTS TO PRACTICE

There is no sharp line of demarcation between what is usually called "pure science" and the application of science to practice. Any properly organized investigation of a practical problem must draw on the information in the archives of pure science and an investigation in pure science almost invariably leads to a problem in application to practice. Indeed, the greatest difficulty in attempting research in pure science in an industrial laboratory is to hold the investigator to the original problem rather than to permit him to follow the tempting leads into the field of applied science.

Investigation of industrial problems requires the same high degree of training and mental fitness which is required in the investigation of those problems which have no point of contact with commercialism.

Breeding to establish the factors governing the transmission of milk producing ability requires as great a familiarity with the established laws of heredity and as great research ability as a study of color transmission in fruit flies or guinea pigs. No one but a chemist thoroughly grounded in physical and organic chemistry should be entrusted with such a problem as the cause of deterioration of milk powder. It is not essential that an investigator of problems of this kind have previous experience

in the manufacture of the product he is to study. It is necessary that he acquire a familiarity as the work progresses, but it takes much less time to make a buttermaker from a chemist than to make a chemist from a buttermaker.

Dairy problems, particularly manufacturing problems, usually involve more than one science, and in our laboratories we find that the work is greatly expedited if a team can be organized to attack the problem from several sides at once. Such a team usually consists of a chemist, a bacteriologist, and a technical man experienced in the manufacture of the particular product studied. For the latter positions there is a need of men experienced in manufacturing work or in the technical side of dairy herd management, who are also sufficiently well grounded in the basic sciences to qualify them for research work.

While a real investigator will produce results in spite of inadequate and defective equipment, progress is much more rapid in properly equipped laboratories. In an industrial laboratory the equipment should include manufacturing equipment to enable investigators to make the product on which they are working under properly controlled conditions.

In the Bureau of Dairying laboratories we are equipped for making various types of cheese, butter, ice cream, condensed and evaporated milk, milk powder, milk sugar, and other by-products. This equipment is all on a small scale, but so complete that each process can be completed exactly as in a commercial plant. This equipment is supplemented by the herd maintained on our own farm for feeding, breeding, and management investigations, which provides an ample milk supply for the operation of the experimental manufacturing plant. By means of this equipment we are able to carry on manufacturing experiments in close coöperation with what may be considered more strictly laboratory work and to do this at relatively low cost. We have been able to complete the first stages of such problems as the bacterial control of Swiss cheese, the manufacture of Roquefort cheese from cow's milk, the cause of thickening in sweetened condensed milk, and the development of tallowiness in milk powder without carrying the work to a factory.

Someone has truthfully said that a completed investigation is surrounded by interrogation points. The development of a new product suggests many questions as to its possible uses. Milk powder has possible value in baking, in milk chocolate, and in ice cream. Casein has applications too numerous to mention.

Soluble albumen, a product which we have been making experimentally from whey, has been used in invalid's food, and in salad dressing.

In order that we may make a product which will be satisfactory for a particular use it is necessary to become familiar with the process in which it finds its application, and to study the properties which adapt it to that use. In problems of this kind it is obviously more satisfactory to depend on the coöperation of established laboratories rather than to attempt to extend the equipment to cover so many fields.

APPLICATION OF LABORATORY RESULTS TO COMMERCIAL PRACTICE

When a new method has proved satisfactory under laboratory conditions, the work is by no means completed. We must first determine if it will work equally well in the field or factory, ascertain if it is profitable under average conditions, and finally convince the industry that our findings are of value.

There are numbers of reasons why methods which have worked without a flaw in the laboratory may fail when put on a commercial basis. There is first of all the probability of the introduction of factors not entering into laboratory experiments. In our laboratory manufacture we use milk produced on our own farm under better than the average conditions. Milk coming to a factory would almost certainly have a greater variety of bacterial infection, and in some phases of the work there is a probability of the feeds introducing a varying factor in the milk itself. In feeding or breeding work the limited number of animals used may give results which will not hold strictly when applied to a large number.

Perhaps most important of all is the personal factor. A new method put into commercial practice passes out of the control of its originator into the hands of operators who, perhaps, do not

understand the principles involved and who may even be hostile to its introduction. The almost invariable tendency under such conditions is to attempt modifications and improvements.

A laboratory process must necessarily be modified to adapt it to varying commercial conditions, but this should be done by someone sufficiently familiar with the principles involved to avoid fundamental errors, and who is interested in correcting defects rather than in condemning the method used.

Some phases of dairy investigation are provided with opportunities for full scale experimentation in the herds and farm connected with the experiment stations, but the side concerned with the manufacture of dairy products has not usually been so fortunate.

The need for facilities for commercial scale work in dairy products has long been recognized by the Bureau of Dairying, and after two or three rather unsatisfactory attempts at coöperative arrangements, a plant was established which, while it is self-supporting, is equipped and available at all times for the manufacture on a commercial or semi-commercial scale, of all ordinary products. This serves not only for testing new methods and products, but also as a laboratory for investigations in the business of operating a creamery. Such problems as the cost of various factory operations, the transportation of milk and cream, and creamery accounting methods can be studied very readily under these conditions. Although it was never intended to be a demonstration plant, this side of its operation can not be entirely eliminated. It is very important, however, that a clear distinction be made between experimentation and demonstration. The casual visitor is very unlikely to distinguish between an experiment and a demonstration, and unfortunate reports frequently originate through this failure.

This plant serves also as a training school for men for special work in the field. In its primary function it has already rendered valuable service in the opportunity it has given for the manufacture of such cheese as Swiss, Roquefort, and Camembert on an extensive scale and for an extended period before new methods are offered to the public.

THE DISSEMINATION OF RESULTS

When an investigator has satisfied himself that his method or product is of value he still has before him the task of convincing an incredulous public. Not only is the investigator impelled by his laudable desire to see the results of his investigation serving a useful purpose, but the public which in one or another way has paid the cost of investigation is entitled to some return on its investment. Notwithstanding all that the public has at stake in the results of research, it is slow to adopt new ideas. There is usually no difficulty in finding people with limited experience and inadequate financial resources who are willing to undertake new ventures, but the more reliable and experienced manufacturers are ordinarily willing that their competitors should do the experimenting.

The investigator in dairying may disseminate his results through the medium of special bulletins, the scientific or trade journals, the public press, the teaching force of the schools and colleges, or by demonstration.

The advantages and the limitations of department and experiment station bulletins are well known. The scientific journals reach only a limited field, but like the bulletins, serve as a permanent record. They are undoubtedly the best means of acquainting other investigators and teachers with technical details and scientific facts. The trade jounals and the public press serve to arouse interest in new projects, but are not satisfactory for complete exposition. The teachers are, very properly, conservative and pass on to their students only those principles and methods which have become established. With certain types of results a demonstration is the only satisfactory method of convincing the public of their value within a reasonable time.

The Bureau of Dairying is organized to provide for the systematic demonstration of any results which have given sufficient evidence of their commercial value. This is done through coöperation with the proper state organization and with the understanding that the assistance of the Bureau will be withdrawn whenever the project is satisfactorily established.

As an illustration of organization and methods of conducting an investigation, I may cite the work which we have done on Swiss cheese. When this work was started the Swiss cheese industry was well established in three States in this country, but the domestic cheese suffered by comparison with the imported, and the market discriminated against it. The methods of the factory did not deviate from those brought from Switzerland. The investigations in Europe were fragmentary and inconclusive and had not affected factory practice. Our investigations for a number of years were confined to the laboratory, and included chemical and bacteriological work carried on in close coöperation with small scale manufacturing. From this work there gradually evolved a method of controlling the bacterial development and the manufacturing processes which gave us under laboratory conditions a high percentage of satisfactory cheese. These methods were then put into practive on a commercial scale in the Grove City creamery, and two or three years devoted to the control of defects which developed on account of the poorer quality of the milk and the greater variety of bacterial contamination.

Coöperative arrangements have been made with two States for the demonstration of these methods, and in one State especially they have been firmly established in several factories. This work could be done at first in only one or two factories which were fortunate in having a liberal minded cheesemaker, or were unfortunate in making such a high percentage of inferior cheese that they were willing to try any remedy.

Now these factories are combined in an organization supporting a laboratory to supply cultures, and a cold storage for holding and selling their cheese. It is expected that in the near future the organization will be sufficiently well established to maintain its own field man and laboratory, and the Bureau can transfer its efforts to another field.

With any one stage of the development of this project omitted we would have now merely some printed records of an incompleted investigation and the public would have nothing to show for the many thousands of dollars expended.

Research in dairying, in common with research in nearly all industrial lines, suffers from the lack of proper organization and coördination of projects and from a deficiency of properly trained investigators. Possibly the first defect is a corollary of the second. It is encouraging, however, to observe the marked improvement which has taken place in a comparatively short time in the nature of the problems undertaken, the training and experience of the investigators and the technique of experimentation.

THE EFFICIENCY OF UTILIZATION OF PROTEIN IN MILK PRODUCTION, AS INDICATED BY NITROGEN BALANCE EXPERIMENTS[1]

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This paper is based upon data obtained by E. B. Forbes and associates in a series of 60 mineral and nitrogen balances with milch cows at the Ohio Agricultural Experiment Station, the main results having been published in Ohio bulletins Nos. 295, 308, 330 and 363, in the years 1916–1922.[2]

In these experiments the determination of the nitrogen balances was incidental to the project of investigation of the mineral metabolism, and in the above mentioned publications little use was made of the nitrogen balances, except for general confirmatory purposes in connection with the balances of the other elements studied, especially sulphur, calcium, and phosphorus.

Especial reasons for conservatism in the interpretation of this extensive series of nitrogen balances lay in the well-known adaptability of animals to different planes of protein intake, the extensive possible use of protein for energy production, and the slowness with which final effects of a particular level of protein consumption are attained.

Having refrained from attempts to use these nitrogen balances in a critical manner as the experiments have been worked up, one at a time, we have now undertaken to derive from the accumulated data average figures for efficiency of utilization of protein as indications of the proportion of the protein of the feed

[1] Received for publication October 20, 1924.

[2] *Note:* Throughout this paper the four series of balances, conducted in different years, are designated as experiments numbered to correspond with the numbers of the bulletins cited, in which the main results of the experiments have been published.

which is recoverable in the milk. Also a comparison is made between the nutrient requirements of milk production, as observed in these experiments, and the computed requirements according to the Morrison standard.

CONDITIONS OF EXPERIMENTATION

The balance experiments involved were conducted as a major interest, under favorable conditions, with rigorous attention to detail, and without compromise on account of the lack of any facility or attention understood to be essential to the proper conduct of the investigation.

Trained chemists were present, and usually actually engaged, in all processes which affected results. This signifies the preparation, mixing and weighing of the feeds, the feeding, care and weighing of the animals, the oversight of the collection and weighing or measuring of the excreta, and the mixing, sampling and preservation of the experimental products—the last function being performed at all times by the most experienced assistant of the laboratory staff.

If, on any account, seriously disqualifying conditions arose, the individual animals affected were immediately dropped from the experiment. There was no refused feed to be accounted for in any case.

As a general procedure all observations which could not be checked at a later date were read by two persons as they were taken and recorded.

The metabolism stalls were in a high, well-lighted and well-ventilated room in a brick building. Steam heat was available; all experiments were conducted in the winter time; and the temperature of the room was maintained, with considerable care and comparatively little departure from specification, at 50° to 55°F.

The subjects of the experiments were grade or pure-bred Holstein Friesian cows, in the prime of life, mostly in the first half of a period of lactation, though a few were at later stages. They were of the better sort ordinarily obtainable, the average daily milk production being 42.6 pounds (19.337 kgm.). In one period

only was one cow bred. Cow 1, period 1, experiment 363, was in the 49th to the 68th days of pregnancy. Otherwise all of the cows were farrow.

The animals stood, or lay, upon mattresses stuffed with excelsior; were curried daily, and provided every comfort practicable under the circumstances. They could lie down and arise with freedom and at will, but no exercise outside the metabolism stalls was permissible.

In general the preliminary feeding periods were of seven to ten days, and the collection periods, from ten to twenty days duration. For the purpose of this study 45 individual period records out of the 60 available were selected, 15 being excluded on obvious accounts, such as the cows' being dry, or too far advanced in the period of lactation. The average length of the 45 experimental periods used was eighteen days.

Tables 1a, 1b and 1c comprise a statement of background data as to length of periods, live weights, weights of feeds and weights of milk produced.

In all but three of the 45 balances selected the roughage was alfalfa or clover hay, of excellent quality. In three balances the roughage was timothy hay.

The grain ration was based upon corn meal, in all cases, and in addition liberal proportions of high-class nitrogenous concen-

The mineral supplements administered were without observable effect on the milk yield, and, inasmuch as they have already been discussed at length, will receive no further mention here.

The plane of feed intake was as determined by giving the cows all that they could be depended upon to clean up absolutely without waste. This signifies that they were not quite up to full feed. When cows are eating to capacity they normally do some picking and choosing; especially they reject some of the less palatable parts of the roughage; but in these experiments there was no refused feed whatever.

As a starting point in determining the amount of feed to allow we began with a distinctly light ration, which was gradually increased toward the amount required, as indicated by prevailing rules of practice. Then as this provisional standard was ap-

TABLE 1a

Length of experimental periods, live weights of cows, average daily rations, average amounts of milk produced, and percentages of fat in the milk

EXPERIMENT	PERIOD NUMBER	COW NUMBER	LENGTH OF PERIOD	LIVE WEIGHT OF COW	AVERAGE DAILY RATIONS	MILK PRODUCED	FAT IN MILK
			days	*kgm.*	*grams*	*kgm.*	*per cent*
295	I	1	19	476	Corn 4248; cottonseed meal 1160; timothy hay 3620; corn silage 11340; salt 23.9	18.405	3.14
		2	19	443	Corn 4300; cottonseed meal 1240; timothy hay 3620; corn silage 13600; salt 28	17.485	2.53
		3	19	481	Corn 3774; cottonseed meal 1241; timothy hay 5440; corn silage 11340; salt 23.3	19.854	2.51
		4	10	359	Corn 4325; cottonseed meal 818; clover hay 4080; salt 25.4	14.818	3.37
		5	10	411	Corn 4515; cottonseed meal 818; clover hay 4080; salt 25.4	14.358	2.76
		6	10	352	Corn 4310; cottonseed meal 815; clover hay 4080; salt 25.4	15.409	3.32
	II	1	20	479	Corn 3000; cottonseed meal 1000; clover hay 4536; corn silage 11340; salt 28	18.462	3.24
		2	20	452	Corn 3000; cottonseed meal 1000; clover hay 4536; corn silage 11340; salt 28	16.485	2.72
		3	20	470	Corn 3000; cottonseed meal 1000; clover hay 4536; corn silage 11340; salt 28	18.605	2.64
		4	20	373	Corn 2270; distiller's grains 1730; clover hay 4082; corn silage 5444; salt 28	14.325	3.03
		5	20	426	Corn 2270; distiller's grains 1730; clover hay 4082; corn silage 5444; salt 28	14.793	3.20
		6	20	371	Corn 2270; distiller's grains 1730; clover hay 4082; corn silage 5444; salt 28	15.904	3.66
	III	1	20	475	Corn 3000; linseed oilmeal 1250; clover hay 4536; corn silage 11340; salt 28	17.804	3.12
		2	20	464	Corn 3000; linseed oilmeal 1250; clover hay 4536; corn silage 14516; salt 28	15.229	2.74
		3	20	468	Corn 3000; linseed oilmeal 1250; clover hay 4536; corn silage 14516; salt 28	18.183	2.64
		4	20	380	Corn 2270; gluten feed 1720; clover hay 4536; corn silage 9072; salt 28	14.476	2.69
		5	20	434	Corn 2270; gluten feed 1720; clover hay 4536; corn silage 10886; salt 28	14.999	2.97
		6	20	381	Corn 2270; gluten feed 1720; clover hay 4536; corn silage 10886; salt 28	15.240	3.53

TABLE 1b

Length of experimental periods, live weights of cows, average daily rations, average amounts of milk produced, and percentages of fat in the milk

EXPERIMENT	PERIOD NUMBER	COW NUMBER	LENGTH OF PERIOD	LIVE WEIGHT OF COW	AVERAGE DAILY RATIONS	MILK PRODUCED	FAT IN MILK
			days	*kgm.*	*grams*	*kgm.*	*per cent*
308	I	1	20	532	Corn 4092; cottonseed meal 546; wheat bran 546; linseed meal 273; corn silage 13636; clover hay 4544; salt 28.4	17.560	2.87
		2	8	478	Corn 3519; cottonseed meal 469; wheat bran 469; linseed meal 235; corn silage 13636; alfalfa hay 5456; salt 28	23.622	3.99
		4	14	436	Corn 4092; cottonseed meal 546; wheat bran 546; linseed meal 273; corn silage 11360; alfalfa hay 3636; salt 28	20.528	2.85
		5	20	455	Corn 4092; cottonseed meal 546; wheat bran 546; linseed meal 273; corn silage 13636; clover hay 4544; salt 28.	18.779	2.77
		6	20	508	Corn 4092; cottonseed meal 546; wheat bran 546; linseed meal 273; corn silage 13636; clover hay 4544; salt 28	20.012	3.23
	II	1	20	520	Corn 4092; cottonseed meal 546; wheat bran 546; linseed meal 273; corn silage 14544; clover hay 4644; salt 28; bone flour 70	20.224	3.03
		2	20	486	Corn 4092; cottonseed meal 546; wheat bran 546; linseed meal 273; corn silage 15908; alfalfa hay 7272; salt 56	26.468	3.27
		3	20	395	Corn 4432; cottonseed meal 590; wheat bran 590; linseed meal 295; corn silage 13636; alfalfa hay 3636; salt 56	23.117	2.88
		4	20	447	Corn 4092; cottonseed meal 546; wheat bran 546; linseed meal 273; corn silage 12728; alfalfa hay 4544; salt 56; bone flour 70	21.875	3.27
		5	20	461	Corn 4772; cottonseed meal 637; wheat bran 637; linseed meal 318; corn silage 15452; clover hay 4544; salt 28; calcium carbonate 70	20.413	2.69
		6	20	515	Corn 4092; cottonseed meal 546; wheat bran 546; linseed meal 273; corn silage 14544; clover hay 4544; salt 28; calcium carbonate 70	20.441	3.14

TABLE 1c

Length of experimental periods, live weights of cows, average daily rations, average amounts of milk produced, and percentages of fat in the milk

EXPERIMENT	PERIOD NUMBER	COW NUMBER	LENGTH OF PERIOD	LIVE WEIGHT OF COW	AVERAGE DAILY RATIONS	MILK PRODUCED	FAT IN MILK
			days	*kgm.*	*grams*	*kgm.*	*per cent*
330	I	1	20	440	Corn 4989; cottonseed meal 907; linseed oilmeal 907; wheat bran 454; alfalfa hay 7256; salt 42	23.068	2.79
		3	20	488	Corn 4989; cottonseed meal 907; linseed oilmeal 907; wheat bran 454; alfalfa hay 7256; salt 42	20.244	2.70
		4	20	422	Corn 4989; cottonseed meal 907; linseed oilmeal 907; wheat bran 454; alfalfa hay 7256; salt 42; precipitated bone flour 70	20.841	3.36
		5	20	422	Corn 4989; cottonseed meal 907; linseed oilmeal 907; wheat bran 454; alfalfa hay 7256; salt 42; precipitated bone flour 70	21.642	2.95
		6	20	500	Corn 4989; cottonseed meal 907; linseed oilmeal 907; wheat bran 454; alfalfa hay 7256; salt 42; precipitate bone flour 70	21.261	2.76
	II	1	20	448	Corn 4989; cottonseed meal 907; linseed oilmeal 907; wheat bran 454; alfalfa hay 8164; salt 42; calcium lactate 11.3	23.261	2.62
		2	10	381	Corn 3743; cottonseed meal 681; linseed oilmeal 681; wheat bran 340; alfalfa hay 7256; salt 42; calcium lactate 55.6	15.142	3.37
		4	16	424	Corn 4989; cottonseed meal 907; linseed oilmeal 907; wheat bran 454; alfalfa hay 8164; salt 42; calcium chloride 40	22.002	3.20
		5	20	429	Corn 4989; cottonseed meal 907; linseed oilmeal 907; wheat bran 454; alfalfa hay 8164; salt 42; calcium chloride 40	22.696	2.87
		6	20	514	Corn 4989; cottonseed meal 907; linseed oilmeal 907; wheat bran 454; alfalfa hay 8164; salt 42; calcium chloride 40	22.086	2.60
363	I	1	20	501	Corn 5161; cottonseed meal 397; linseed oilmeal 397; wheat bran 397; alfalfa hay 7720; salt 44.5; precip. bone flour 55; precip. calcium carbonate 55	19.400	2.89

TABLE 1c—*Continued*

EXPERIMENT	PERIOD NUMBER	COW NUMBER	LENGTH OF PERIOD	LIVE WEIGHT OF COW	AVERAGE DAILY RATIONS	MILK PRODUCED	FAT IN MILK
			days	*kgm.*	*grams*	*kgm.*	*per cent*
363	I	2	20	531	Corn 4791; cottonseed meal 369; linseed oilmeal 369; wheat bran 369; alfalfa hay 7720; salt 41.3	17.180	3.10
		5	20	440	Corn 4791; cottonseed meal 369; linseed oilmeal 369; wheat bran 369; alfalfa hay 7720; salt 41.3; precip. bone flour 47.1; precip. calcium carbonate 47.1	18.430	2.90
		6	20	448	Corn 5161; cottonseed meal 397; linseed oilmeal 397; wheat bran 397; alfalfa hay 8172; salt 44.5.	22.505	3.22
	III	3	10	467	Corn 5083; cottonseed meal 1017; wheat bran 2033; alfalfa hay 5448; salt 56.9 Fowler's solution 40.	24.708	2.47
		4	10	488	Corn 5083; cottonseed meal 1017; wheat bran 2033; alfalfa hay 7264; salt 56.9 precip. bone flour 53.7; precip. cal. carb. 53.7; Fowler's solution 40	27.833	3.00

proached individual deviations were made in the amount either of grain or roughage, or of both, as necessary concessions to the preferences of the experimental subjects.

The proportion of protein in the rations was considered to be liberal. Our desire was that it be as high as could be of possible benefit as affecting the retention of the mineral nutrients.

In an effort to get the cows onto their experimental rations promptly, however, and to fix upon amounts of feed which they could be depended upon to clean up, the amounts adopted were doubtless less, in many cases, than they would have been had there been no necessity for getting onto the experimental basis with the least practicable delay.

A point to bear in mind is that the conditions of the experimental subjects in the 45 selected balances were comparable only in general terms. The plane of feed intake, the proportion of pro-

tein to non-protein nutriment, and the intimate nature of the protein combinations in the rations, were similar, but not identical. It is impossible, therefore, to treat the results as though representing ideal conditions in these regards.

Fur further details as to conditions and methods of experimentation the reader is referred to the publications already cited.

DISCUSSION OF RESULTS

Tables 2a and 2b set forth the statistical results to be discussed. As a basis for judgment of the significance of these data an exhibit portraying the plane of nutrition will be helpful. Thus, the fourth column from the left (feed N divided by maintenance N) indicates the plane of nitrogen intake, in terms of the maintenance requirement of nitrogen.

The sufficiency of the feed intake is indicated, in relation to the nitrogen and the live-weight balances, in the two columns at the right of the table, and in relation to the Morrison feeding standard, in the third and fourth columns from the right.

In full realization of the limited significance of the individual data, we feel justified in considering that the averages of the 45 nitrogen and live weight balances have a definite value.

Of the 45 nitrogen balances 13 were negative, and 32 were positive, the average balance being +8.1 grams—thus indicating clearly that in general the nitrogen intake was sufficient to maintain equilibrium.

Of the 45 live-weight balances 24 were positive and 19 negative. In one case there was no change, and in another the data were lacking. On the average the live-weight was just maintained.

The indication, then, is that both the nitrogen and the total feed intake were, on the average, sufficient for maintenance of nutritive equilibrium during the production of 42.6 pounds of milk.

In comparison with the Morrison standard, however, the determined, apparently digestible crude protein intake was below the computed requirement in 40 of the 45 instances, the average deficiency being 0.69 pound per head; the total digestible nutri-

ents also being below the computed requirement in 40 of the 45 instances, the average deficiency being 1.84 pounds.

TABLE 2a

Data relating to the utilization of the nitrogen of rations for milk production. Averages per day

EXPERIMENT	PERIOD NUMBER	COW NUMBER	N OF FEED	FEED N + MAINTENANCE N	N IN MILK	N IN BODY GAIN	UTILIZED N + FEED N	UTILIZED N + FEED N LESS MAINTENANCE N	DEFICIENCY OF NUTRIENTS FED: MORRISON STANDARD		N BALANCE	CHANGE IN LIVE WEIGHT
									Protein	Total		
			gram		*grams*	*grams*	*per cent**	*per cent*	*pounds†*	*pounds‡*	*grams*	*grams*
295	I	1	207.5	4.55	66.7	+11.5	37.7	48.3	1.35	4.60	+11.5	−79
		2	221.2	5.22	45.9	+34.3	36.2	44.8	0.85	−0.12	+34.3	+771
		3	218.4	4.74	45.7	+29.2	34.3	43.5	1.29	2.42	+29.2	−800
		4	186.8	5.43	41.6	+30.9	38.8	47.6	0.84	2.36	+30.9	0
		5	189.8	4.82	33.7	+11.2	23.7	29.9	0.80	1.82	+11.2	+360
		6	186.4	5.53	42.0	+8.7	27.2	33.2	0.97	3.08	+8.7	−240
	II	1	225.2	4.91	67.8	+20.1	39.0	49.0	1.22	4.32	+20.1	−100
		2	225.2	5.21	49.6	+20.8	31.2	38.6	0.77	0.79	+20.8	+480
		3	225.2	5.01	49.3	+43.4	41.2	51.4	1.04	2.54	+43.4	+253
		4	204.9	5.73	53.2	+9.9	30.8	37.3	0.69	1.80	+9.9	−187
		5	204.9	5.02	49.2	+2.8	25.4	31.7	0.93	3.15	+2.8	+440
		6	204.9	5.76	60.3	+4.6	31.7	38.3	1.08	3.89	+4.6	−7
	III	1	216.8	4.77	71.2	+5.7	35.5	44.9	1.09	2.52	+5.7	+327
		2	225.8	5.08	56.1	+9.4	29.0	36.1	0.66	−0.84	+9.4	+620
		3	225.8	5.04	52.6	+9.1	27.3	34.1	1.13	0.66	+9.1	−7
		4	205.5	5.65	55.1	+2.9	28.2	34.3	0.67	−0.23	+2.9	+580
		5	210.6	5.07	49.8	+9.8	28.3	35.3	0.82	1.05	+9.9	+553
		6	210.6	5.77	56.1	+9.7	31.2	37.8	0.83	0.87	+9.7	+453
308	I	1	239.8	4.71	87.0	−8.4	32.8	41.7	1.01	0.73	−8.4	+185
		2	280.5	6.13	97.9	−8.8	31.8	38.0	1.03	2.54	−8.8	−1827
		4	245.8	5.88	72.3	+7.0	32.3	38.9	0.87	2.05	+7.0	+849
		5	239.8	5.51	68.2	+6.4	31.1	38.0	1.14	0.52	+6.4	−473
		6	239.8	4.92	87.0	−5.6	33.9	42.6	1.50	3.49	−5.6	+11

* Utilized N = milk N plus body gain or minus body loss.

† Apparently digestible crude protein, experimentally determined.

‡ Total digestible nutrients, starch-equivalent basis; experimentally determined.

At face value these data indicate that the Morrison standard calls for distinctly more protein and more total nutriment than

TABLE 2b

Data relating to the utilization of the nitrogen of rations for milk production. Averages per day

EXPERIMENT	PERIOD NUMBER	COW NUMBER	N OF FEED	FEED N + MAINTENANCE N	N IN MILK	N IN BODY GAIN	UTILIZED N + FEED N	UTILIZED N + FEED N LESS MAINTENANCE N	DEFICIENCY OF NUTRIENTS FED: MORRISON STANDARD		N BALANCE	CHANGE IN LIVE WEIGHT
									Protein	Total		
			grams		*grams*	*grams*	*per cent*	*per cent*	*pounds*	*pounds*	*grams*	*grams*
308	II	1	253.7	5.09	82.5	+0.8	32.8	40.8	1.30	2.94	+0.8	−1193
		2	338.5	7.28	102.4	−8.2	27.8	32.3	1.05	1.58	−8.2	+191
		3	260.4	6.87	89.8	−0.1	34.4	40.3	1.26	3.88	−0.1	−451
		4	267.8	6.25	86.3	+1.8	32.9	39.2	0.93	2.11	+1.8	−77
		5	277.1	6.27	83.2	+13.0	34.7	41.3	0.98	−0.32	+13.0	+97
		6	253.7	5.14	85.4	+11.6	38.2	47.4	1.27	2.19	+11.6	+227
330	I	1	309.5	7.34	109.8	−13.0	31.3	36.2	0.45	2.54	−13.0	−320
		3	309.5	6.62	89.3	−6.0	26.9	31.7	0.26	1.25	−6.0	−240
		4	309.6	7.66	92.9	−9.7	26.9	30.9	0.53	2.46	−9.7	−313
		5	309.6	7.64	94.1	−3.2	29.4	33.8	0.42	1.81	−3.2	+20
		6	309.6	6.46	96.3	−5.0	29.5	34.9	0.33	2.05	−5.0	+140
	II	1	386.6	9.01	113.7	+26.2	36.2	40.7	−0.50	0.20	+26.2	+433
		2	319.0	8.74	76.5	+20.8	30.5	34.5	−0.73	−0.58	+20.8	
		4	386.5	9.53	99.0	+23.9	31.8	35.5	−0.35	1.39	+23.9	+168
		5	386.5	9.41	100.3	+25.4	32.5	36.4	−0.50	0.03	+25.4	+27
		6	386.5	7.85	100.5	+23.9	32.2	36.9	−0.58	0.14	+23.9	+680
363	I	1	303.4	6.32	83.0	+0.2	27.4	32.6	0.29	1.25	+0.2	−430
		2	294.3	5.79	77.7	−5.7	24.5	29.6	0.22	2.02	−5.7	−890
		5	294.4	6.98	79.0	−5.3	25.0	29.2	0.24	1.10	−5.3	+430
		6	313.7	7.31	92.5	−0.4	29.4	34.0	0.56	2.78	−0.4	+330
	III	3	315.5	7.06	97.2	+2.2	31.5	36.7	0.51	2.82	+2.2	−530
		4	358.2	7.66	124.4	+6.0	36.4	41.9	0.72	5.30	+6.0	−380
Average.....				6.19			31.6	38.0	+0.69	+1.84	+8.1	+1.8
Probable error of average.....							±0.4	±0.5				
Probable error of single variate.....							±2.8	±3.7				

is required, but detracting from the basis for such an indication are the facts (1) that these cows were not bred, the nutritive requirements being less than normal on this account; (2) that the maintenance requirement of energy, under the conditions of the experiments, was probably less than normally prevails in practice; and (3) that the quality of the ration was distinctly above the average. The excessive requirements (or factors of safety) of protein and total digestible nutrients, according to the Morrison standard, therefore, were probably less than as indicated by the data—but just how much less are not matters of record.

Frankly, it is questionable whether any balance data should be considered competent, by themselves, to modify the Morrison standard, since all results obtained under laboratory conditions must be checked up under the practical conditions to which they are to apply. The suggestion, however, is that the Morrison standard is fully as high as the actual requirements.

In computing the nutritive requirement according to the Morrison standard (1) we used, in all cases, the average of the upper and the lower figures given; and in computing the feed-nutrient equivalent of the milk produced we interpolated for the nearest quarter-per cent of fat.

Columns 5 and 6, from the left, set forth the nitrogen of the milk and of the body gain or loss; and the algebraic sum of the two (which we have considered the utilized nitrogen) divided (1) by the feed nitrogen, in column 7, and (2) by the feed nitrogen minus the maintenance nitrogen, in column 8, gives us two figures, on different bases, for efficiency of utilization of the nitrogen of the ration.

The average efficiency of utilization of feed nitrogen (column 7) was 31.6 per cent, ± 0.4 per cent, the standard deviation being 4.1 per cent, and the probable error of a single variate 2.8 per cent.

The average efficiency of utilization of utilizable nitrogen (feed nitrogen less maintenance nitrogen, column 8) was 38.0 per cent, ± 0.5 per cent, the standard deviation being 5.4, and the probable error of a single variate 3.7 per cent.

Attention is called to the fact that the figure for nitrogen utilized covers constructive purposes only, nitrogen used for

maintenance not being included, and that it is, in a sense, of mixed significance, in that it is the resultant in each case of two out of a group of three factors, the quantitative relations of which are not definitely known, to wit—(1) the nitrogen of the milk produced, (2) the nitrogen of the body gain, and (3) the nitrogen of the body loss.

In this connection it should be realized that the efficiency of utilization of the nitrogen of a particular ration may be prominently affected by the capacity of the cow to retain nitrogen as body gain, as determined by the previous plane of nitrogen intake. If the cow had been on a high plane of nitrogen intake, in the months previous to the experiment, it might be impossible for her to store any nitrogen (while in a farrow condition), no matter how generous the nitrogen intake; while, on the other hand, under other conditions as to previous feeding, she might store nitrogen rapidly and efficiently.

Whatever the conditions the nitrogen of the body gain must be considered as nitrogen utilized, and is reckoned as representing an equal amount of milk nitrogen, while the nitrogen lost from the body is considered to represent an equivalent diminution of the milk nitrogen; though we do not know accurately the quantitative relations between milk nitrogen and nitrogen of body gain or loss.

Also, if the true maintenance requirement of nitrogen is as variable, among individuals, as the maintenance requirement of energy is known to be, our measure of the plane of nitrogen intake (feed N divided by computed maintenance N) is far from a constant.

It is thus apparent that we do not have an entirely consistent and satisfactory basis for computing the amount and efficiency of the utilization of nitrogen; however, the results presented are not without value.

An effort to establish the existence of a definite relation between the plane of feed intake (as represented by the ratio of feed nitrogen to maintenance nitrogen) and the efficiency of utilization of feed nitrogen, was unsuccessful; that is, there was no observable tendency for the efficiency of utilization of nitrogen to vary regu-

larly with the plane of intake. Assuming that there is in reality such a relationship—it seems to have been obscured, in these data, by the various existing differences in experimental conditions.

Referring to the paper of Fries, Braman and Kriss (2) the nitrogen requirement of milk production, computed in relation to the feed nitrogen, is decidedly less in the experiments here discussed, because the cows were more efficient producers, in the sense that the maintenance requirement of nitrogen was a smaller part of the nitrogen intake; but the nitrogen requirement of milk production on the feed-minus-maintenance basis was much greater in the experiments here discussed because the cows were good producers, and so were liberally fed, while the maximum efficiency of utilization of nitrogen, on this basis, would prevail only during very limited nitrogen intake and milk production. In the experiments here discussed the fact that there was, on the average, a slight nitrogen storage (8.1 grams) indicates that the nitrogen intake exceeded the requirement by amounts which we have no means of estimating, and that if less nitrogen had been fed the efficiency of utilization, on either basis, would have been somewhat higher.

CONCLUSIONS

In a group of 45 balance periods, averaging eighteen days in length, with farrow Holstein Friesian cows in the first half of the period of lactation, producing, on the average, 42.6 pounds of milk per day, on a plane of feed intake sufficient, on the average to maintain slight nitrogen storage and live-weight equilibrium, the average utilization of feed nitrogen for milk production and body gain was 31.6 per cent, ± 0.4 per cent, and the utilization of utilizable nitrogen (feed minus maintenance) was 38.0 per cent, ± 0.5 per cent.

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DIFFERENT TYPES OF MILK, THEIR RELATION TO THE RENNET, AND THEIR IMPORTANCE IN CHEESEMAKING*

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According to well known scientific methods of today we are able to regulate the coagulation of milk by rennet in such a manner that a well developed coagulum is assured.

This is accomplished, first, by eliminating such milk as does not coagulate properly; second, by regulating the degree of maturity of a part of the milk to be manufactured; third, by using a pure rennet extract, well started in its lactic acid fermentation; and last, by adapting the required quantity of rennet to the peculiarities of the milk.

By carefully performing these different operations the cheesemaker is enabled to impart to his milk ability to coagulate with rennet, which guarantees to him a normal process of manufacture and a first-class product.

According to O. Hamarsten[1], the process of rennet coagulation in milk is separated into two well defined phases; first, a preparation phase, transforming the casein into a sensitive state for coagulation, and second, a coagulation phase, coagulating the para-casein complex.

The duration of the first of these two phases, the preparation phase, is limited by the time during which the milk to which rennet has been added remains liquid. The second phase begins first, with the formation of a flaky coagulum and remains in this state until the proper formation of the gel. This latter state is in a certain sense to be considered as the end phase of the phenomenon of coagulation, and includes the time from the

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[1] Lehrbuch fur physiol. chemie, 1907, vi, Aufl.

first visible gelatinization of the coagulum to the more or less perfect formation of the gel. It may here be remarked that it is inherent in the phenomenon of coagulation that the several parts of its different phases are not clearly defined. The successive states of development overlap, so that at certain times very different transformation states may be observed. From the standpoint of the technique of cheesemaking, as well as from purely theoretical considerations, the structure of the gelatinization of the rennet coagulum is the especially important part of the coagulation phase in forming the curd.

In returning to more practical considerations, we find that the cheesemakers, for quite a long time, paid special attention to these phenomena of coagulation, pre-phase, coagulation, and gelatinization. The first phase, the so-called "dicklegen," or thickening of the milk, is considered to last from the time of the addition of the rennet through the "ziehen," or period of increased viscosity. After that comes coagulation proper, with its first flaky liquid stage, followed by the more or less quick transformation into the gel. The jelly thus formed then undergoes a certain number of transformations which the cheesemaker can accurately determine by means of simple tests, one of which is "Griff," or the "feel" of it. The development of the proper jelly state is very closely observed by the cheesemaker. He tries to guide the development of the different stages of the jelly in a definite direction, by means of different operations, such as turning over, cutting the curd, and heating.

Aided by long experience, the capable operator is able to separate clearly the different phases of coagulation and to study its peculiarities. These observations enable him to judge his milk and to regulate the process of manufacture.

As stated above, the cheesemaker possesses ways and means to control at least a part of the process of coagulation according to his desire. This is especially true of the so-called rennet reaction. According to the valuable researches of O. Allemann and H. Schmid[2], a certain duration of the rennet reaction equals a certain course of the coagulation phase; so that by regulation

[2] Landw. Jahrbuch der Schweiz, 1916, p. 357.

of the duration of the rennet reaction, quickness, as well as kind, of jelly formation is determined. The two named workers have shown that the intensity of jelly formation, that is, the degree of firmness of the coagulum obtained in a certain time, is inversely proportional to the duration of rennet action. It may, therefore, be assumed that in the most favorable cases of the regulation of the rennet action, the kind of jelly formation is also defined. This, of course, is limited to those cases where neither of the two phases of the rennet coagulation process already described is separately disturbed, that is, is either retarded or stimulated. Such discrepancies in the relation between duration of rennet action and kind of jelly formation may well be observed in different types of milk. It is of special importance in practical cheesemaking that these types of milk have the tendency to impart in a remarkable degree their abnormal properties to normal milk. It may sound strange to hear from cheesemakers the assertion that they can "feel" the admixture of certain tainted milks to the vat milk during cheesemaking, but such is the case, and science cannot afford to neglect much longer the elucidation of this fact. Here are fruitful facts for further investigation.

Among the problems that present themselves is the important question as to how and in what amount the adding of certain milk types to the vat milk affects the mixture in an unfavorable way. Here we are especially interested in the minor question, as to what kind of influence on the formation and texture of the gel may be expected.

These and other considerations have led us to study more closely these individual milks which do not react normally with rennet. These questions are now in course of investigation, and I refer here briefly to some of the results.

MILK TYPE A[3]

By milk type A we understand the milk which is generally known in Switzerland as "rässalzige" milk, with a salty, pungent

[3] According to the text we understand by this expression the more or less altered secretion of the otherwise healthy milk gland.

The different milk types are distinguished by the letters A, B, C, etc.

taste. We know today that such milk is secreted by the more or less inflamed quarters of the udder. The inflammation is usually caused by different bacteria inhabiting the udder.

Chemically speaking, milk type A is characterized by its differences in composition when compared with normal milk. From a physiological standpoint the following modifications are especially noteworthy:

First, increase in the content of catalase, leucocytes, sodium chloride, highly dispersed nitrogen compounds (globulin and albumin, etc.)

Second, decrease in the content of total dry matter, fat free dry matter, milk sugar, calcium phosphate; the concentration of the hydrogen-ions and degree of acidity are decreased, and the rennet reaction is considerably diminished.

In consequence of such remarkable changes in composition as well as of alteration of a more physico-chemical nature, this secretion is distinctly abnormal in its reaction with rennet. Not only is the time of curdling shortened, but the stage of jelly formation shows a distinctly abnormal development. The peculiarities of this milk type are highly transmissible. If such milk be added to normal vat milk the possibility of manufacture of normal cheese of a high quality is seriously endangered. More extended and profound investigations will demonstrate whether this trouble is not more harmful than is now generally admitted.

Increasing the free hydrogen-ion (acidity) distinctly improves the reaction to rennet of type A. The influence of highly dispersed calcium compounds (calcium chloride) produces the same results.

How far these alterations affect the duration of the rennet reaction and the properties of the rennet gel as far as it can be externally ascertained, and the more delicate physico-chemical states of the latter, is a question that cannot be solved conclusively by simple laboratory experiment.

The results obtained in this manner are not entirely reliable under purely practical conditions. Only extended experiments in the cheese factories themselves could throw more light on this question. By increasing the rennet concentration (use of more

rennet) better results are obtained, when this type of milk is used, either alone or when mixed with normal milk.

The basis for the detection of milk of this type in mixture with other milk is found in the abnormal composition of this product. In questionable cases it is of value to know that the analytical figures vary constantly in the same or approximately the same direction. The same fact can be depended on to show results when a case of slight watering of the milk might be mistaken for the trouble in question. The amount of chlorine and milk sugar present is a guide in these cases.

MILK TYPE B[4]

In this type we meet a peculiar kind of secretion, which is as yet not well known in dairy practice. According to our observations it is not prevalent in Switzerland, where cheese of the Emmental type is manufactured. Only a cow here and there may show the trouble. It is distinguished from type A by the fact that the common analytical methods do not show any deviation from normal milk. With rennet under the usual conditions[5] no reaction takes place, and even after an increase of the hydrogen-ion concentration (acidulation) no effect is observed. If we add rennet to milk of this type in the customary way and let the mixture stand for thirty minutes, we will not be able to detect any changes, but if we now add calcium chloride to the mixture the gel is formed almost at once. This proves that while the conditions necessary for the preparation phase of the rennet reaction are present, those essential to the development of the later phases (coagulation and gelatinization) are lacking. These latter can be released only by the addition of calcium chloride.

How this type B milk originates is at present not known. Some observations not included in this paper tend to show that

[4] Landwirtschaftliches Jahrbuch der Schweiz, 1921, p. 330.

[5] In this experiment the usual standard rennet extract manufactured by the firm Flora at Dubendorf, Zurich, was used. The rennet concentration of the solution was such that normal milk at 35° shows the first flaky precipitate after ten to twelve minutes.

the cause must be inherent in the blood stream; that is, it must be active before the gland cells forming the milk are built up. It is certain that the bacterial flora of the udder has no influence on the occurrence of this trouble.

The chemistry of this milk type has been investigated by van Dam.[6] This worker supposes that such milk lacks the lime that is usually associated with the milk casein, a compound which, on account of its physico-chemical properties, is mainly responsible for the normal coagulation phase. It has already been stated that the chemical composition of this secretion is entirely normal. Especially any explanation which assumes an inflammatory state of the milk gland as the cause of milk type B, cannot be accepted. This kind of milk contains no catalase and no leucocytes. Degree of acidity as well as free hydrogen-ion content is normal. Total lime content and soluble lime (clay cell filtrate) do not give any reason for assuming that the cause of this abnormality could be found in faulty feeding, lack of lime in feedstuffs. Great irregularities in total lime content may be observed when the milk of the different quarters of the same udder is analyzed. One cow, for instance, yielded for two whole lactation periods milk of type B, except at times when a greater concentration of the secretion could be expected on physiological grounds, as for instance stoppage of milk flow caused by grave internal diseases, that is, during the acute stage of foot-and-mouth diseases, etc., and also during the period of the drying up of the cow. At such times a normal rennet reaction could be obtained, but not before or after.

In practice the type B seems not to be as dangerous as type A, because its occurrence is limited and therefore small quantities only are received at the cheese factories.

On account of its normal composition the identification of this type in a mixture with other milk is not easy. The rennet or coagulation test is not reliable except with the pure unmixed secretion.

[6] Zeitschrift für physiologische chemie, 1908-09, lvi, 295.

MILK TYPE C

This type is similar to type B in so far as the results of the customary chemical analysis show no deviation from the normal milk composition. With regard to its origin it resembles very much that of type B. It is only certain peculiarities in its reaction with rennet which make a separation from type B advisable at this time.

Milk type C was first detected in two cheese factories having manufacturing trouble. In these cases it was not possible to attain the necessary degree of dryness of the curd within the customary time, so that the stirring process, "ausrühren," had to be prolonged to sixty or ninety minutes or even longer. The peculiar properties of these milks were already evident at curdling time. The milk in the vat coagulated under the influence of rennet within the usual time limits; but the forming of the normal gel was considerably delayed. This delay continued throughout the entire manufacturing process and different modifications of the working methods did not bring relief.

In both cases of this peculiar trouble a relatively small addition of calcium chloride to the vat milk brought a decided improve ment in the formation of the gel, especially in its end phase, so much so that the drying of the curd took place within the usual time. A further study of these phenomena conclusively demonstrated that the trouble was caused by some abnormal secretion, which, when mixed with the vat milk, influenced unfavorably its gel formation. A little later the offending milk could be isolated. At first we thought of some relation to type A, but soon the peculiar properties of this secretion made us confident that we were dealing with a new type.

With regard to origin of milk type C about the same may be said as for milk type B. Its chemical composition is similar.

As already mentioned, under the standard condition of the experiment, the duration of the rennet reaction may be entirely normal, only the gel formation is extraordinarily delayed. The distinctly curdled milk (first flaky precipitation) remains disproportionately long in its first liquid flaky phase. The evolution of the gel stage, however, is strikingly delayed.

For quite a while, a part of the milk does not share in the gel formation. This is especially to be noted and is doubtless due to the fact that the jelly remains for a relatively long time in a soft, half liquid state. The well known firm, smooth, sharply defined gel block is not formed at all, it is only after some time that we can observe a conglomerate of jelly floating in the milky whey. The contractability of the gel is also visibly lessened.

This delay in the starting and development of the gel is a distinct characteristic of milk type C. The fact that this abnormality is readily imparted to healthy milk is of great practical importance. Laboratory experiments have demonstrated that under standard condition of the experiment additions of only five to ten per cent of type C to normal milk could be readily observed by closely watching the coagulating phase, provided, of course, a strict comparison of the experiments is invariably maintained. Notwithstanding the difference in coagulation the duration of the rennet reaction in normal and tainted samples is almost identical. The unfavorable properties in the different milk samples as we discussed them, seem to be cumulative. The difference manifested itself in the kind of gel formed. When we now consider what the cheesemaker means by "Griff," or "Griffigkeit," the "feel" of it, of the curd, we can readily understand that this is a delicate method of estimating the quality of the curd. It is also evident that the capable cheesemaker, with his trained hand, is better able to detect with certainty small additions of type C to his vat milk than is the analyst with the usual laboratory methods. In laboratory experiments an increase of free hydrogen-ions had the same effect as an addition of normal milk; that is, the duration of the rennet reaction was distinctly shortened, but the quality of the gel was hardly corrected. Addition of calcium chloride to milk containing type C had about the same effect, with the difference, however, that curd formation was improved. In increase of the ferment concentration (larger amount of rennet) did not improve the quality of coagulation, nor was the duration of the rennet reaction appreciably shortened.

According to all observations to date we must pronounce milk

of type C as dangerous for cheesemaking. We are sure that in addition to the factory troubles already investigated[7] more cases will eventually come to our notice, in which the disturbance in manufacturing is caused by milk type C.

The identification of this milk type C by chemical analysis is, as has been stated, difficult enough, because no externally observable abnormal condition, nor a strikingly varied composition is present. The only way of detecting this trouble is by means of the F. Schaffer rennet and coagulation test, used on a strictly comparative basis. In the use of this test it is the time rather than the kind of coagulation which should be observed. It will assist in obtaining good results, if after a certain time (for instance half normal coagulation time), the coagulated milk is tested for development and firmness of the gel. It is very important that when investigating mixed milk (patrons' milk samples) the different tests be compared closely and that completeness of coagulation (condition of whey) be considered as well as firmness of curd.

[7] Schweiz. Milchzeitung, 1923, W. 35, 36, 37, 38, 39, 40, 41, 42.

DEVICE FOR RAPID DETERMINATION OF THE SPECIFIC GRAVITY OF CONDENSED MILK*

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One of the methods of determining the degree of concentration of sweetened condensed milk in the pan is to weigh a definite quantity of a sample on a sensitive balance. A cone-shaped copper cup holding 100 cc., designed by Mr. A. O. Dahlberg when he was a member of the department, has been used for a number of years by this laboratory for this purpose. The chief difficulty has been that when a stream of milk large enough to fill the cup rapidly was drawn, it was very hard to prevent overflowing the narrow opening, and covering the outside of the cup. This made it necessary to take time to wash and wipe the outside. If a small stream was drawn it took too long.

To overcome these difficulties a removable top has been designed to be used when filling the cup. This consists of a circular disk with a circular hole in the center just large enough to fit over the top of the cup. On the under side is a collar fitting closely around the neck of the cup and holding the upper surface of the disk even with the mouth of the cup. The joint between disk and cup is tight, but condensed milk is so thick that a ground joint is not necessary. The disk is of sufficient size to allow any milk dripping over the edge to fall clear.

When ready to take a sample, the removable top is placed upon the cup and the cup is filled direct from the pan until the milk overflows onto the disk. Then the excess milk is removed with a stroke of a spatula, the top removed, and the cup with contents weighed as usual. There may be a few drops of milk on the outside around the neck, but these are quickly removed,

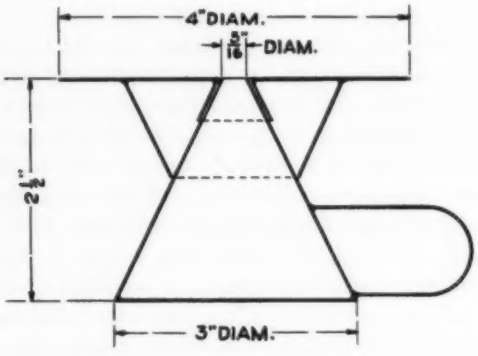
* Received for publication July 20, 1924.

whereas without the top the washing and wiping consume considerable time when quick action is essential. Variations in filling the cup with this devise ordinarily amount to not over 0.1 gram, equivalent to 0.08 degree Beaume.

The advantages of using this top are:

1. The cup may be filled more quickly.
2. The milk is prevented from running over the outside of the cup.
3. Any foam may be floated off over the top.

A diagram of a longitudinal section of the cup and top (fig. 1) is included.



LONGITUDINAL SECTION

FIG. 1

THE SOLUBILITY OF MILK POWDER AS AFFECTED BY MOISTURE CONTENT*

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Solubility is an important feature in judging the physical characteristics of milk powder. The term, "solubility" as used herein refers to the ability of desiccated milk when mixed with water to form a solution, suspension or emulsion which will simulate the physical characteristics of natural milk. The solubility of strictly fresh milk powder varies with the process of manufacture, the acidity of the liquid milk dried, and with certain conditions incident to the operation of the particular drying process involved. Another factor however, of equal, if not greater, significance in determining the degree of solubility of milk powder after a given storage period, is the question of moisture content, either that originally contained in the product or that taken up from the atmosphere.

Decreased solubility of milk powder during storage is a type of deterioration common to powders containing fat and to those made from skimmed milk. The results of studies on the deterioration of these products clearly indicate that this manifestation of deterioration is a direct result of excessive moisture, which in the great majority of cases has been found to be due to the inadequacy of the container for excluding atmospheric moisture, rather than to excessive moisture in the product at the time of manufacture. In view of the importance of this type of deterioration of milk powder, experimental data have been obtained which shows progressive changes in the solubility of the casein of milk powder as caused by varying percentages of moisture.

EXPERIMENTAL

Since the object of this investigation was to determine the effects of original and absorbed moisture on the solubility of

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the proteins, comparisons were made on this constitutent only and not on the basis of the total milk solids. Fresh milk powder made by the Just double roller process was packed in air-tight containers which were so constructed that air could be circulated through the powder at will, or so that the container could be

TABLE 1

Effect of moist air on solubility of proteins of desiccated milk (Just process)

AGE OF SAMPLE	PER CENT MOISTURE IN POWDER	PER CENT TOTAL PROTEIN IN SUSPENSION	PER CENT CASEIN IN SUSPENSION
Fresh	1.95	2.05	1.88
4 days	3.18	2.01	1.65
11 days	5.60	1.80	1.55
18 days	7.57	1.47	1.16
25 days	8.15	1.21	0.98
32 days		0.82	0.68
39 days		0.67	0.46
46 days	10.13	0.43	0.10
53 days	11.49	0.19	None

Total protein in entire sample, 2.95 per cent; total casein in entire sample, 2.43 per cent.

TABLE 2

Effect of moist air on solubility of proteins of desiccated milk (spray process)

AGE OF SAMPLE	PER CENT MOISTURE IN POWDER	PER CENT TOTAL PROTEIN IN SUSPENSION	PER CENT CASEIN IN SUSPENSION
Fresh	1.96	2.27	1.78
7 days	5.77	2.14	1.70
21 days	7.25	1.21	0.92
41 days	9.79	0.80	0.36
52 days	10.80	0.25	None

Total protein in entire sample, 2.37 per cent; total casein in entire sample, 1.84 per cent.

absolutely hermetically sealed as desired. Various samples all from the same original lot of powder were treated as hereinafter described. Analyses were made periodically for moisture, for the total proteins held in suspension after centrifuging, and for the casein suspended in the supernatant liquid. In order to secure uniformity of results throughout the observation period, the total solids in the original liquid milk were determined

and from these data the proper proportions of powder and water were mixed to obtain the same concentration of milk solids in the remade milk as were originally present in the milk before drying. The powder was mixed with water at 65°C. and held for ten minutes with constant stirring, after which a representative sample of 10 cc. was centrifuged for ten minutes at 2000 revolutions per minute on a centrifugal heat 18 cm. in diameter. The total proteins and casein were determined in the supernatant liquid which was easily decanted from the precipitate at the bottom of the tube. Tables 1 and 2 show the results obtained after circulating 1600 cc. of moist air per minute through about 300 grams of powder for a period of sixty minutes per day. The humidity of the circulated air was maintained between 75

TABLE 3

Effect of dry air on solubility of proteins of desiccated milk (Just process)

AGE OF SAMPLE	PER CENT MOISTURE IN POWDER	PER CENT TOTAL PROTEIN IN SUSPENSION	PER CENT CASEIN IN SUSPENSION
Fresh	1.95	2.05	1.88
26 days	2.33	2.01	1.80
76 days	2.63	2.01	1.78
107 days	2.85	2.00	1.78
140 days	2.88	2.01	1.78
174 days	2.88	2.01	1.78

Total protein in entire sample, 2.95 per cent; total casein in entire sample, 2.43 per cent.

and 80 per cent at a temperature of 75° to 80°F. During the intervals when the air was not circulated the powder was hermetically sealed. The protein and casein percentages are recorded on the basis of the original liquid milk. Since it was impossible to make analysis for the total solids in the original liquid milk dried by the spray process, the concentration ratio was determined as near as possible from the dried product. At this point it should be mentioned that the Just process powder was a partial skimmed milk product, whereas, the spray process powder was made from whole milk.

The results given in tables 1 and 2 seem to show conclusively the direct relationship between moisture content and the de-

velopment of insolubility of the casein in milk powder during storage. Regardless of the initial solubility of the powder, the rate of moisture absorption and the resulting insolubility are quite parallel in the powders made by the two different processes.

In table 3 is given the analytical results from Just process powder taken from the same batch as the powder used for the preceding determinations. This sample was handled in the same manner as the former samples, with the exception that

TABLE 4

Effect of moisture content of milk powder on solubility of proteins during storage —moisture 2.30 to 3.50 per cent

AGE OF SAMPLE	PER CENT MOISTURE IN POWDER	PER CENT TOTAL PROTEIN IN SUSPENSION	PER CENT CASEIN IN SUSPENSION
Fresh	1.95	2.05	1.88
21 days	2.30	2.05	1.74
42 days	2.60	2.05	1.68
70 days	2.65	2.04	1.70
100 days	2.55	2.04	1.70
135 days	2.58	2.04	1.70
175 days	2.61	2.01	1.68
210 days	3.01	2.03	1.74
238 days	3.20	2.03	1.74
273 days	3.23	2.04	1.70
298 days	3.50	2.02	1.73
329 days	3.45	1.94	1.70
358 days	3.80	1.83	1.54
369 days	7.00	0.35	None

Total protein in entire sample, 2.95 per cent; total casein in entire sample, 2.43 per cent.

the circulated air was first dried to a very low humidity. During the first twenty-six days there was a slight but measurable decrease in the solubility of the proteins, but thereafter, and for a period of about five months during which the dried air was continually circulated there was no measurable change in the solubility of the casein. These results are significant in showing that whatever rôle air alone (normal gases of the atmosphere with the exception of water vapor) may play in the deterioration of other constitutents of milk powder, it is not a factor in causing

insolubility of the proteins, but that this latter type of deterioration is due entirely to moisture.

The foregoing results were obtained under an artificial air and moisture environment and therefore do not permit of direct interpretation in terms of time and moisture content which bring about the development of a given degree of insolubility under normal conditions. In order to obtain further data on this particular point, the fresh powder taken from the same

TABLE 5

Effect of moisture content of milk powder on solubility of proteins during storage —moisture 4.20 to 5.20 per cent

AGE OF SAMPLE	PER CENT MOISTURE IN POWDER	PER CENT TOTAL PROTEIN IN SUSPENSION	PER CENT CASEIN IN SUSPENSION
Fresh	1.95	2.05	1.88
21 days	4.40	2.01	1.70
42 days	4.74	1.92	1.62
70 days	4.75	1.90	1.61
100 days	4.70	1.90	1.60
135 days	4.75	1.89	1.60
175 days	4.87	1.90	1.62
210 days	4.83	1.91	1.62
238 days	5.13	1.85	1.49
273 days	5.15	1.85	1.44
298 days	5.20	1.79	1.40
329 days	5.10	1.46	1.13
358 days	5.15	1.41	1.13
365 days	6.49	0.94	0.64
369 days	6.55	0.89	0.59

Total protein in entire sample, 2.95 per cent; total casein in entire sample, 2.43 per cent.

lot as was used for the previous tests was subjected to a treatment whereby the moisture content of three different samples was brought to a desired point immediately after manufacture. These samples were packed in containers of such a type that the moisture content could be easily controlled within one per cent for an indefinite period. Analyses were made at regular intervals for approximately one year, or until there was an absence of suspended casein after reconstituting and centrifuging as already described. In table 4 is shown the results from powder with

moisture content maintained between 2.30 and 3.50 per cent for about one year. Similar figures are shown in table 5 for powder with a moisture content maintained between 4.30 and 5.30 per cent for the same period. Since it was desired to discontinue this work after one year and because the progress of deterioration has been clearly determined by that time the moisture content of these two samples was rapidly raised during the last few days of the observation period, with results which are entirely in harmony with those previously recorded.

TABLE 6

Effect of moisture content of milk powder on solubility of proteins during storage —moisture approximately 5 per cent

AGE OF SAMPLE	PER CENT MOISTURE IN POWDER	PER CENT TOTAL PROTEIN IN SUSPENSION	PER CENT CASEIN IN SUSPENSION
Fresh	1.95	2.05	1.88
21 days	5.15	1.99	1.62
42 days	5.15	1.87	1.59
70 days	5.20	1.86	1.56
100 days	4.95	1.88	1.58
135 days	4.95	1.86	1.56
175 days	4.95	1.86	1.58
210 days	4.95	1.34	1.05
238 days	4.85	1.12	0.69
273 days		0.56	0.16
298 days	5.10	0.42	0.08
329 days		0.22	None

Total protein in entire sample, 2.95 per cent; total casein in entire sample. 2.43 per cent.

In table 6 is shown the results from a sample in which the moisture content was maintained as near 5 per cent as was possible. In this sample it was found that the casein had become insoluble in less than one year, and although the moisture content of this sample was not much greater than the sample shown in table 5, there was nevertheless, a marked difference in the solubility of the proteins at the end of any particular period which might be selected for comparison.

The analyses of the material precipitated by centrifuging reconstituted Just process milk powder showed from 93 to 94

per cent of the dry weight to be protein material and the remainder mineral matter. The average ash content of three samples of desiccated milk was found to be 6.846 per cent; 22.64 per cent of the ash was calcium oxide; 29.94 per cent was phosphorus pentoxide; and 2.32 per cent was magnesium oxide. The combined amounts of these constituents amounted to 54.90 per cent of the total ash. Analysis of the oven dried percipitate obtained by centrifuging the same three samples after remixing with water gave an average ash content of 7.653 per cent; 61.67 per cent of the ash was calcium oxide; 33.97 per cent was phosphorus pentoxide; and 2.65 per cent was magnesium oxide. The combined amounts of these constituents amounted to 98.29 per cent of the total ash in the sample of precipitated material. Although it is not within the scope of this paper to discuss changes in solubility of the salts of milk brought about by this method of desiccation, analysis of the precipitated mineral matter show that some of the calcium salts of the original liquid milk are altered so that their precipitation by centrifugal force is easily accomplished. It is probable that the greater part of the precipitated mineral matter is soluble calcium phosphate. These results are in accord with the observations of other investigators who have shown that a precipitation of calcium takes place during the heating and desiccation of milk.

SUMMARY

A review of the data herein shows conclusively that the development of insolubility of proteins of milk powder during storage is due to the presence of moisture. There was a complete absence of casein in suspension after centrifuging under definite conditions at the end of seven to eight weeks during which time about 100 liters of moist air (humidity 70 to 75 per cent) were circulated daily. During this period and under the conditions of the test, the water content of the powder increased from under 2 to about 11 per cent.

The absorption of moisture and consequent development of insolubility of the casein was essentially the same in powders made by the Just double cylinder process and the spray process.

Moisture-free air circulated through milk powder at the same rate as the humid air did not cause any change in the solubility of the proteins within a period of six months, and from the results and character of the powder at the end of that time it is believed the proteins would retain their original solubility indefinitely, or as long as moisture was entirely excluded.

The original solubility of the casein of milk powder can be maintained for a year or more if the moisture content is kept below 3 per cent during the storage period. In powder with a moisture content maintained between 4 and 5 per cent there was a greater degree of insolubility throughout a period of one year than in those samples in which the moisture content was maintained at 3 or lower. Samples in which the moisture content was maintained from about 3 to about 5 per cent and in which the solubility had shown but slight change during a period of one year, became almost entirely insoluble within a few days when the moisture content was suddenly raised to 6.5 to 7 per cent. Samples in which the moisture content was maintained as near 5 per cent as possible throughout a period of one year showed greater insolubility than those samples in which the moisture content was gradually raised from 4 to 5 per cent during the same period.

The material precipitated by centrifugal force from reconstituted Just process milk powder contains approximately 93 per cent protein material and 7 per cent ash. The ash is almost entirely composed of the oxides of calcium, phosphorus and magnesium. From the analysis it appears that insoluble calcium phosphate is the principle constituent of the precipitated mineral matter.

SOME NOTES ON THE EFFECT OF HEAT ON MEMBERS OF THE COLON TYPHOID GROUP IN MILK[1]

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The possibility of members of the colon-typhoid group surviving the pasteurization process is one of ever present interest and significance. The report below is a brief outline of some experiments which bear on this problem.

HISTORICAL

Twiss (1920) revived interest in this question when she stated that infected milk which had been heated to 60°C. and held there for a definite time and then cooled and incubated often gave growth of the organism tested. Quite a few strains of the typhoid-paratyphoid group were found to withstand 65°C. for thirty minutes in milk. Krumwiede and Noble (1921) were stimulated by the work of Twiss to test the validity of her conclusions. They stated that there was no evidence to show that members of the typhoid-paratyphoid group could endure 60°C. beyond twenty minutes. They also stated that to remove all doubt about the technic the samples of milk should be completely submerged in the bath. Krumwiede and Noble explained Twiss' results on the ground that cotton-plugged flasks were used along with other flaws in technic. It may be argued, however, that the heating of milk in closed tubes as suggested by Krumwiede and Noble does not simulate the conditions of actual pasteurization where the heating is carried out in open containers. Rosenau (1912) stated that the holding of milk at 60°C. for two minutes destroyed Bacterium typhosum. The great majority of the cells was destroyed by the time the milk reached 59°C. The dysentery bacillus was found to be a little more resistant than the typhoid bacillus. Wedemann (1919) inoculated milk with Bac-

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terium coli communis, Bacillus suipestifer, Bacillus pyocyaneus, and the human and bovine strains of the tubercle bacillus. Biorization was found to destroy these bacteria. Ayers and Johnson (1915) noted considerable variation in the ability of 174 strains of Bacterium coli to survive pasteurization temperatures. At 60°C. 54.59 per cent of the cultures survived while at 62.8°C., 6.89 per cent survived. It was stated, however, that 62.8°C. was the critical temperature for Bacterium coli in milk and that 65.5°C. should destroy the organism. Shippen (1915) also found that Bacterium coli could survive the temperatures used in pasteurization. The thermal death point was found to be variable. In the case of Bacterium coli communior this variation was found to be as great as 13°C.

EXPERIMENTAL

The apparatus used was that which is ordinarily found in the bacteriological laboratory. The only important special apparatus was a DeKhotinsky oil-bath containing Crisco which was used as the constant temperature device. With this it was very easy to regulate the temperature to within a fraction of a degree.

The first experiment consisted in heating milk cultures of the organisms in test tubes in an oil bath at 60°C. Two cubic centimeters of the milk cultures were delivered with sterile pipettes to the bottom of sterile test tubes 6 inches long, the greatest of care being used to prevent any milk getting onto the sides of the test tubes. These tubes were then put into racks and immersed in the oil bath to within an inch of the top of the tube. At intervals shown in table 1, loopfuls of the milk were removed and inoculated onto sterile agar slants. At the end of the experiment the contents of the test tubes were poured into sterile petri dishes with agar in order to determine whether there were any viable organism.

Examination of the data in table 1 indicates that even with a heavily infected milk, there is such a reduction in the numbers of bacteria that no viable cells were secured in loopfuls after fifteen minutes. Bacterium coli seemed to be the most resistant. However, when the milk remaining in the test tubes was poured into petri dishes with melted agar and incubated at 37°C.

for 24 hours there were a few colonies showing that a few cells survived even thirty minutes at 60°C.

The samples in this case were heavily seeded with young cells since they were twenty-four hour milk cultures. That undoubtedly accounts for the fact that a few cells were alive after thirty minutes when the whole remaining sample was tested. However, in no case using loops could viable cells be detected after fifteen minutes. These organisms were shown to give their characteristic changes on Endo's medium, Russell's double sugar agar, and lead acetate agar. This experiment was repeated with the same results with the exception that viable Bacterium coli cells could be detected for twenty minutes.

Our results in testing the remaining portion of milk in the test tube by pouring it into sterile petri dishes are in accord with

TABLE 1

	HEATING TIME IN MINUTES									CONTENTS OF TUBES POURED INTO DISHES 24 HOURS 37°C.
	2.5	5	7.5	10	12.5	15	20	25	30	
Bacterium coli.....	+	+	+	+	+	+	−	−	−	+
Bacterium typhosum.....	+	+	−	−	−	−	−	−	−	−
Bacterium paratyphosum A.	+	+	+	−	−	−	−	−	−	−
Bacterium paratyphosum B.	+	+	−	−	−	−	−	−	−	−
Bacterium dysenteriae.....	+	+	+	−	−	−	−	−	−	+

those of Twiss who stated that negative tests on comparatively small amounts cannot be taken as proof of the death of all organisms.

The second experiment consisted in using 0.5 cc. of a twenty-four hour broth culture of the organisms in 2 cc. of sterile milk. These tubes were heated in the oil bath at 60°C., under the same conditions as in the first experiment. The results are shown in table 2.

Comparison of the results from experiments I and II bear out the fact that the rate of death of bacteria by moist heat is a time process and depends on the number of cells which are present. In the first experiment, the number of cells was large compared to the numbers which were present in the second experiment.

There was a very satisfactory reduction from many millions to just a few colonies after thirty minutes heating at 60°C.

The third experiment consisted in heating milk which had been inoculated with 0.5 cc. of a salt suspension of the organisms. All other conditions and precautions were identical with those given under the first experiment. The results of this experiment were identical with those shown in table 2 with the exception that Bacterium coli was found to be viable for 10 minutes.

These experiments indicate that the strains were killed in much less time than thirty minutes. When twenty-four hour milk cultures were used a few viable cells were detected by pouring all of the remaining milk into petri dishes. The organisms which

TABLE 2

	HEATING TIME IN MINUTES											REMAINING MILK IN THE TEST TUBES POURED INTO STERILE TEST TUBES
	2.5	5	7.5	10	12.5	15.0	17.5	20	22.5	25	27.5	30	
Bacterium colon	+	+	+	+	−	−	−	−	−	−	−	−	No growth
Bacterium typhosum	+	+	−	−	−	−	−	−	−	−	−	−	No growth
Bacterium paratyphosum A	+	+	−	−	−	−	−	−	−	−	−	−	No growth
Bacterium paratyphosum B	+	+	−	−	−	−	−	−	−	−	−	−	No growth
Bacterium dysenteriae	+	+	−	−	−	−	−	−	−	−	−	−	No growth

survived were thought to have been devitalizd since the colonies did not appear readily until the plates had been incubated for more than twenty-four hours.

The fourth experiment was conducted with sealed tubes and the DeKhotinsky oil bath. The tubes used were those which were first used by Bigelow and Estey. They were 250 mm. long, 7 mm. inside diameter and 1 mm. thick. They have many advantages in the thermal death point work over the Sternberg bulb. These tubes were sterilized in the autoclav and the two sets were heated.

One set contained 2 cc. of a salt suspension of the organisms diluted about one third with sterile whole milk. The tubes were sealed off in a flame and placed in a Wassermann rack. The oil bath was regulated at 60°C. The rack holding the tubes was put into the bath and tubes removed at definite intervals. Im-

mediately after removal these tubes were plunged into ice water to stop the action of the heat. At the end of the experiment, the contents of these tubes was poured into sterile petri dishes and plated out in agar. The results are shown in table 3. None of the strains lived beyond fifteen minutes. The milk left in the tube when poured into a sterile Petri dish, showed no living cells.

As a check on this, the same experiment was repeated with the exception that the cells were suspended in sterile salt solution. The concentration of the cells was the same as shown in table 3. *Bacterium coli* lived for less than five minutes, *Bacterium* typhosum just a little longer. None of the organisms lived for a period longer than ten minutes even though comparatively large numbers of cells were used. It is to be remembered that closed tube heat-

TABLE 3

Salt suspension of cells in milk

	CELLS PER CUBIC CENTIMETER	HEATING TIME IN MINUTES										
		1	2	3	5	7.5	10	12.5	15	20	25	30	35
Bacterium colon	1,000,000	+	+	+	+	+	−	−	−	−	−	−	−
Bacterium typhosum	100,000,000	+	+	+	+	+	−	−	−	−	−	−	−
Bacterium paratyphosum A	180,000,000	+	+	+	+	+	−	−	−	−	−	−	−
Bacterium paratyphosum B	66,000,000	+	−	+	+	−	−	−	−	−	−	−	−
Bacterium dysenteriae	100,000,000	+	+	+	+	−	−	−	−	−	−	−	−

ing results may not be accurately compared with results collected with open tubes. In closed tubes the pressure may augment the action of the heat.

The last and fifth experiment was carried out after the technic of Miss Twiss except that larger flasks were used and a fresh sterile pipette used for the withdrawal of each 1 cc. specimen. One liter flasks containing 500 cc. of milk were sterilized in the autoclav. A sterile thermometer was placed in the flask and the flask heated on a hot plate to 60°C. It was then placed in the oil bath which was kept constant at 61.5 °C. The flask was placed down in the oil so that as much of its interior surface as possible was exposed to the action of the heat. Ten cubic centimeters of a twenty-four hour milk culture of the organisms used, were then introduced and carefully stirred into the milk. At inter-

vals of one-half of a minute, 1 cc. portions were removed from the flask and plated out on dextrose agar. As stated above, each 1 cc. portion was removed with a fresh sterile pipette instead of using the same one for removing the samples. The plates were then incubated at 37°C., and the colonies counted after twenty-four to fourty-eight hours. Every attempt was made to keep the milk way below the oil line on the flask. The results are given in table 4.

Epidemiological evidence that pasteurization destroys typhoid bacilli was furnished by Geiger and Kelly (1916). The milk from a large dairy producing almost 700 gallons per day was infected by a carrier. Ninety gallons of this milk was delivered to a substation in Richmond and 600 gallons to a substation in

TABLE 4

NAME OF ORGANISM	NUMBER OF CELLS PER CUBIC CENTIMETER	TIME REQUIRED TO DESTROY WHEN 1 CC. PORTIONS WERE TESTED
		minutes
Bacterium colon	2,000,000	7
Bacterium typhosum	3,500,000	1
Bacterium paratyphosum A	1,000,000	1
Bacterium paratyphosum B	500,000	2
Bacterium dysenteriae	1,000,000	1

This experiment was repeated twice, three times in all with concordant results.

Berkeley. The Richmond supply was not pasteurized while the Berkeley supply was. There was an epidemic of typhoid fever in Richmond traced to the milk while in Berkeley with its pasteurized supply, there was none. As Geiger and Kelly stated this shows that pasteurization destroyed the infective agent in the milk. Further epidemiological evidence is available in the experience of Chicago over a period of eleven years. As pasteurization became more common there was a general and constant decrease in the typhoid fever rate.

SUMMARY

The results of these experiments indicate that the members of the colon-typhoid group in milk in the numbers to which they would occur are destroyed by heating for thirty minutes at 60°C.

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A COMPARATIVE STUDY OF METHODS FOR DETERMINING THE PER CENT OF BUTTERFAT IN DAIRY PRODUCTS[1]

I. ICE CREAM

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Recently, with the commercial introduction in this country of the Gerber method for the determination of fat in dairy products, there has arisen anew the question as to the practicability and accuracy of this method as compared with the Babcock and Mojonnier methods.

As milk and cream are now sold principally on a butterfat basis, and as standards for butterfat have been established for practically all dairy products by State and Federal Governments, the test for fat in dairy products is probably the most important and widely used test in the dairy industry. Because of this importance of the fat test to the industry and in view of the fact that relatively few comparisons between the Babcock and the Mojonnier method, and none that the authors know of on all three methods, have been made, it seemed desirable to compare the practicability and accuracy of these three tests as applied to the various dairy products.

At the time when this problem came to our attention, the most urgent need was for facts on fat tests for ice cream. Therefore, the first series of trials were made on this dairy product.

PROCEDURE

Forty-six samples of ice cream were tested by each of the three methods. The procedure of each of these tests is outlined below.

Preparation of the sample

The sample was collected by using a long butter trier or sampler reaching to the bottom of the ice cream can. Trierfuls of ice

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cream were taken from different parts of the can and then placed in a half pint milk bottle which, after receiving the sample, was tightly stoppered with a San Lac seal cap. The sample was then melted by placing in a water bath at about 25°C. As soon as melted, the sample was thoroughly mixed and charges weighed out for each of the three methods studied.

A. Modified Babcock. There have been proposed numerous modifications of the Babcock Fat Test for milk and cream so as to make it applicable to ice cream. Considerable time was given over to deciding which one of these modified Babcock methods gave the best results. After making five duplicate determina-

TABLE 1

Percentages of fat in ice cream as obtained by the Mojonnier and the (alcohol-sulphuric acid) modified Babcock test

SAMPLE NUMBER	MOJONNIER METHOD		MODIFIED BABCOCK METHOD	
	Original	Duplicate	Original	Duplicate
1	11.31	11.30	11.20	11.10
2	13.93	13.91	12.50	12.50
3	13.23	13.42	13.00	13.00
4	12.56	12.50	12.40	12.30
5	10.31	10.30	10.00	10.10

tions on each of five different modified Babcock tests for ice cream, the following was finally selected:

Weigh 9 grams of well mixed sample of ice cream into an 8 per cent milk test bottle. Add 10 cc. of 95 per cent ethyl alcohol, shake well and add 9 cc. of commercial sulphuric acid (specific gravity 1.82 to 1.83). Complete test as for milk. Multiply the results by two.

Compared with the Mojonnier and from the standpoint of clear and well defined fat column, this alcohol and sulphuric acid method gave the best results of any of the modified Babcock methods that were tried out. Table 1 shows results obtained with the alcohol and sulphuric acid test in these preliminary trials.

B. Gerber or Troy-Fucoma method. The Gerber fat test for milk and cream has been modified by H. C. Troy so as to make

it applicable to ice cream. As the equipment is placed on the market by the Fucoma Co., the method is generally known as the Troy-Fucoma method.

The directions for making the test, as published by the Fucoma Co., were followed exactly and are briefly as follows:

1. Measure 10 cc. of diluted commercial sulphuric acid (94 cc. of acid to 6 cc. of water for chocolate ice cream or 87 cc. of acid to 13 cc. of water for other flavors) into special ice cream test bottle.
2. Weigh exactly 5 grams of well mixed sample into test bottle using care to let the ice cream run down the side of the test bottle and spread over the surface of the acid without mixing it.
3. Add 6 cc. of water and 1 cc. of amyl alcohol; insert rubber stopper and mix contents by inverting test bottles until contents are thoroughly mixed.
4. Centrifuge immediately at a speed of 1000 to 1200 revolutions per minute for about four minutes.
5. As soon as centrifuging is completed place in waterbath at 140°F. and read the fat tests by screwing the rubber stopper in or out till the bottom of the fat column is at the zero mark.

C. Mojonnier method. The directions for testing ice cream for fat by the Mojonnier method, as outlined in "Technical Control of Dairy Products," Mojonnier and Troy, (page 109), were followed exactly.

RESULTS

The percentages of fat obtained on forty samples of ice cream by each of the three methods are tabulated in table 2. Thirty-eight of these samples were plain vanilla, while the two others were strawberry ice cream. An additional six samples of chocolate ice cream were also analyzed by each of the three methods. These are reported separately in table 3. To obtain a fair index as to the relative accuracy of the Troy-Fucoma and the modified Babcock methods for determining the per cent of fat in ice cream, it is necessary to compare them with a standard method of analysis, which is generally accepted as reliable and accurate. The Mojonnier or modified Roese-Gottleib method meets this requirement. Using, therefore, the Mojonnier method as the standard

TABLE 2

Percentages of fat in ice cream as determined by the Mojonnier, the Troy-Fucoma and modified Babcock method

SAMPLE NUMBER*	MOJONNIER	TROY-FUCOMA		MODIFIED BABCOCK		PER CENT VARIATION	
		Original	Duplicate	Original	Duplicate	Gerber from Mojonnier	Modified Babcock from Mojonnier
1	10.65	11.00	10.90	10.80	10.80	+0.30	+0.15
2	11.47	11.20	11.00	11.00	11.10	−0.37	−0.42
3	13.97	13.60	13.50	14.00	14.10	−0.42	+0.08
4	8.13	8.20	8.40	8.00	8.05	+0.17	−0.10
5	9.77	10.40	10.40	9.00	10.00	+0.63	−0.27
6	11.65	11.80	11.90	11.50	11.40	+0.20	−0.20
7	14.43	14.20	14.00	13.40	13.50	−0.33	−0.98
8	10.58	9.80	10.00	9.50	9.60	−0.68	−1.03
9	13.62	13.00	13.20	13.20	13.00	−0.52	−0.52
10	13.73	13.80	13.90	13.50	13.40	+0.12	−0.28
11	13.37	13.50	13.70	13.00	12.90	+0.23	−0.42
12	11.31	11.60	11.40	11.10	11.20	+0.19	−0.16
13	13.23	13.20	13.40	13.00	13.00	+0.07	−0.23
14	12.56	12.60	12.60	12.40	12.30	+0.04	−0.21
15	10.31	10.80	10.90	10.10	10.10	+0.54	−0.26
16	11.87	11.20	11.20	11.70	11.60	−0.67	−0.22
17	15.47	15.40	15.40	15.30	15.20	−0.07	−0.22
18	13.71	14.00	13.80	13.70	13.51	+0.19	−0.11
19	13.31	12.40	12.60	13.30	13.20	−0.81	−0.06
20	11.54	12.20	12.00	11.10	11.20	+0.56	−0.39
21	11.83	10.50	10.40	11.00	11.00	−1.38	−0.83
22	13.91	13.80	13.80	13.40	13.50	−0.11	−0.46
23	14.15	13.60	13.80	14.00	13.90	−0.45	−0.20
24	13.44	13.20	13.20	13.60	13.40	−0.24	+0.06
25	13.15	13.80	13.90	13.00	12.80	+0.70	−0.24
26	13.38	14.20	14.00	13.50	13.40	+0.72	+0.07
27	13.36	13.80	13.80	12.50	12.50	+0.44	−0.86
28	11.11	10.20	10.10	11.00	11.50	−0.96	+0.14
29	17.05	17.00	17.00	17.00	17.00	−0.05	−0.05
30	14.07	15.00	14.80	14.80	15.00	+0.83	+0.83
31	13.67	14.10	14.20	13.20	13.20	+0.48	−0.47
32	14.39	13.60	14.00	14.00	14.00	−0.59	−0.39
33	15.66	15.60	15.80	15.60	15.60	+0.04	−0.06
34	13.66	13.60	13.80	14.00	13.80	+0.04	+0.24
35	12.55	12.40	12.20	12.40	12.30	−0.25	−0.20
36	13.44	13.60	13.40	13.10	13.00	+0.06	−0.39
37	12.95	12.80	12.80	13.60	13.40	−0.15	+0.55
38	14.42	15.20	15.00	15.00	14.90	+0.68	+0.53
39	13.57	13.20	13.00	13.20	13.30	−0.47	−0.32
40	14.72	14.80	15.00	14.40	14.50	+0.18	−0.27
Average variation						0.39	0.34

* All samples were vanilla ice cream except nos. 1 and 4.

for comparison, the per cent of variation of each of the Troy-Fucoma and the modified Babcock from the Mojonnier, are reported also in table 2.

A study of table 2 shows that from the standpoint of accuracy, using the Mojonnier as a standard of comparison, there is practically no difference between the Troy-Fucoma and the modified Babcock method. Thus in the case of the Troy-Fucoma 67.6 per cent of all samples checked within 0.5 per cent; while with the modified Babcock method 85 per cent of all samples checked within 0.5 per cent of the Mojonnier. A still better analysis

TABLE 3

Summary of percentages of variation of Troy-Fucoma from Mojonnier method

9 samples or 28.5 per cent checked within 0.1	of 1 per cent of Mojonnier
14 samples or 37.5 per cent checked within 0.2	of 1 per cent of Mojonnier
19 samples or 47.5 per cent checked within 0.3	of 1 per cent of Mojonnier
22 samples or 55.0 per cent checked within 0.4	of 1 per cent of Mojonnier
27 samples or 67.5 per cent checked within 0.5	of 1 per cent of Mojonnier
36 samples or 90.0 per cent checked within 0.75	of 1 per cent of Mojonnier
39 samples or 97.5 per cent checked within 1.00	of 1 per cent of Mojonnier

Summary of percentages of variation of modified Babcock from Mojonnier method

8 samples or 20.0 per cent checked within 0.1	of 1 per cent of Mojonnier
17 samples or 42.5 per cent checked within 0.2	of 1 per cent of Mojonnier
24 samples or 60.0 per cent checked within 0.3	of 1 per cent of Mojonnier
30 samples or 75.5 per cent checked within 0.4	of 1 per cent of Mojonnier
34 samples or 85.0 per cent checked within 0.5	of 1 per cent of Mojonnier
35 samples or 87.5 per cent checked within 0.75	of 1 per cent of Mojonnier
39 samples or 97.5 per cent checked within 1.00	of 1 per cent of Mojonnier

may be made from the summary reported in table 3. The average variation from the Mojonnier on forty samples was 0.39 per cent in the case of the Troy-Fucoma and 0.34 per cent for the modified Babcock method. While this, as well as the summary in table 3 would seem to indicate slightly more favorable results for the modified Babcock, the difference is too slight to be of any significance. Moreover, when interpreting these results it must always be remembered that in studies of this type there enters in a personal factor. Before drawing final conclusions as to the practicability and accuracy of any particular method, it

therefore is not only desirable but necessary that comparisons such as reported in this paper be repeated in different laboratories and by several operators.

It is interesting to note that in 22 out of 40 samples, the Troy-Fucoma gave somewhat higher results than the Mojonnier. In the case of the modified Babcock only 9 samples were slightly higher while the other 31 gave results somewhat lower than the Mojonnier.

Both methods, more particularly, the Troy-Fucoma, gave uniformly clear, amber colored fat columns except for the chocolate ice cream. In the case of the chocolate ice cream, notwithstanding the special precautions as to strength and amount of acid, the fat columns in both tests frequently were indefinite or indistinct. Moreover the results obtained in practically all instances were lower than the Mojonnier.

TABLE 4

Percentages of fat in chocolate ice cream as determined by the Mojonnier, the Troy-Fucoma and a modified Babcock method

SAMPLE NUMBER	MOJONNIER	TROY-EUCOMA		MODIFIED BABCOCK		PER CENT VARIATION	
		Original	Duplicate	Original	Duplicate	Gerber from Mojonnier	Modified Babcock from Mojonnier
1	10.53	8.60	8.50	9.80	8.50	−1.98	−1.78
2	9.75	8.00	8.20	10.40	10.50	−1.65	+0.70
3	14.53	13.20	13.40	14.00	14.15	−1.23	−0.45
4	11.35	11.20	11.40	10.50	10.60	−0.05	−0.80
5	12.02	10.80	11.00	11.00	11.05	−1.12	−0.99
6	13.93	13.50	13.90	13.50	13.50	−0.08	−0.43

Table 4 reports the percentages of fat in six samples of chocolate ice cream as determined by each of the three methods. While duplicate determinations of each method check closely in practically all of the six samples of chocolate ice cream, there is a large variation as compared with the Mojonnier. The nature of the chocolate or cocoa solids seemingly is such that the sulphuric acid fails to dissolve all the solids not fat or at least in some manner their properties prevent all of the fat from reaching the

fat column. Judging from the uniformly low results, some of the fat is evidently held imprisoned by undissolved solids not fat or fibrous material from the cocoa.

SUMMARY

1. In order to study the relative value of methods for determining the per cent of fat in ice cream, 46 samples were analyzed for fat by the Mojonnier, the Troy-Fucoma and a modified Babcock method.

2. Using the Mojonnier method as a standard for comparison, the results indicate that the Troy-Fucoma and the modified Babcock method used in this study rate approximately the same from the standpoint of accuracy.

3. The average per cent of variation from the Mojonnier on 40 samples was 0.39 per cent for the Troy-Fucoma and 0.34 per cent in the case of the modified Babcock method.

4. Both the Troy-Fucoma and the modified Babcock method seem well adapted for ordinary factory use where simplicity and rapidity of the test are important considerations; however, results obtained in this study would seem to make it questionable if their use is justified in instances where careful analytical results are desired.

5. It seems desirable to continue the study of these methods for determining fat in ice cream with special reference to comparing results obtained by different laboratories and operators.

ANNUAL MEETING OF THE AMERICAN DAIRY SCIENCE ASSOCIATION[1]

GENERAL SESSION

The nineteenth annual meeting of the American Dairy Science Association was held in connection with the National Dairy Exposition at Milwaukee, Wisconsin, September 29, 1924.

The general association meeting was held in Englemann hall, Milwaukee auditorium, Monday, September 29, 1924.

After a few brief remarks by President Borland the minutes of the 1923 meeting were read and approved. The report of the secretary-treasurer was read and adopted. A budget of $575 suggested by the Executive Committee was adopted for 1925.

The following Nominating Committee was appointed to report back to the meeting: E. S. Guthrie, chairman, L. A. Morley, O. G. Shafer, H. W. Gregory, and J. R. Dice. This committee reported the following nominations to be voted on by mail ballot before January 1, 1925: For president, O. E. Reed, H. B. Ellenberger; for vice-president, H. F. Judkins, W. M. Regan.

Under the head of divisional reports R. C. Fisher reported on the meeting of the Eastern Division and C. E. Wylie on the Southern Division meeting. No report was made of the Western Division. C. H. Eckles reported for the committee to consider affiliation with the Union of American Biological Societies. The committee recommended that the American Dairy Science Association join this Union provided the cost is not too great. Their report was adopted and the secretary instructed to notify the officers of the Biological Union of the action.

C. H. Eckles and J. A. Gamble reported on the National Research Council. A report of the meetings of the American Dairy Federation was given by O. E. Reed.

A. M. Loomis, secretary of the American Dairy Federation, was present and announced the banquet of the Federation for

[1] These proceedings are complete except for Section III, report of which has not yet come to the Editor.

Wednesday, October 1, 1924. He also raised the question as to whether this Association would be an associate or active member in the Federation, this to be determined by the financial support given by the American Dairy Science Association.

J. H. Frandsen spoke of the JOURNAL OF DAIRY SCIENCE as did also J. A. Gamble.

A. C. Dahlberg presented a resolution on the death of Dr. Geo. A. Smith, of Geneva, New York. The resolution was adopted and a picture and statement regarding Mr. Smith will be published in the *Journal*.

The following addresses were given before a large audience: "The Research Work of the U. S. Dairy Bureau," by L. A. Rogers, U. S. Dairy Bureau. (This address appears elsewhere in this issue of the *Journal*.) "The Training and Compensation of the Research Worker," by E. D. Ball, U. S. Dept. of Agriculture.

J. H. Frandsen spoke of the possibility of creating a junior membership to the Association to include dairy students in the different colleges. C. H. Eckles mentioned the possibility of organizing local groups of the Association. After further discussion by H. A. Harding and R. C. Fisher a motion was made to appoint a committee to formulate plans and make suggestions for creating junior membership. The following committee was appointed: C. H. Eckles, chairman; J. H. Frandsen; J. B. Fitch.

As a result of a request from the International Milk Dealers Association it was moved and adopted that a committee be appointed to cooperate with the International Milk Dealers Association. H. A. Ruehe, R. C. Fisher, and G. D. Turnbow were appointed on this committee.

The question of the personnel of the Executive Committee was raised by the secretary. This was discussed by Eckles. It seemed to be the opinion that the Executive Committee, as set forth in the constitution, was sufficiently representative and less cumbersome than a larger committee.

Professor Eckles suggested that the Executive Committee consider the feasibility of having the Association meet before the opening of the Dairy Show in this way making it possible for the

members to devote a day or so to the business of the Association and see the Dairy Show as well. This matter has been suggested at other times and the sentiment in favor of this arrangement is increasing. It was moved and adopted that arrangement should be made to hold the meetings of the Association either before or after the Dairy Show or at such a time that they will not conflict with the main events of the Dairy Show. The meeting adjourned at noon until 1:30 p.m. when the sectional programs were given.

BANQUET

September 30, 1924; 6:30 p.m.

Toastmaster. O. E. Reed, E. Lansing, Mich.

The American Dairy Science Association, its work and purposes:

The Production Section. J. A. Gamble, College Park, Md.

The Manufacturing Section. H. W. Gregory, Lafayette, Ind.

The Extension Section. L. W. Morley, State College, Penn.

The Advanced Registry Section. Roy Harris, Madison, Wis.

The United States Dairy Bureau. C. W. Larson, Chief U. S. Dairy Bureau.

Why Dairying—in Science and in Practice? Dean H. L. Russell, University of Wis.

Announcement of Awards and Presentation of Prizes in the Inter-Collegiate Judging Contests.

PRODUCTION SECTION

The Production Section of the American Dairy Science Association was called to order in Room-A Milwaukee Auditorium at 2 p.m., September 29, 1924, by J. A. Gamble.

Professor Gamble explained the unavoidable absence of Chairman J. J. Hooper and asked J. P. LaMaster of South Carolina to act as Secretary.

The minutes of the previous meeting were read and approved.

Prof. E. B. Hart of the University of Wisconsin gave an illustrated lecture on "Twenty Years Progress in Animal Nutrition." This address was most enthusiastically received and it was one of the most outstanding addresses of this year's meeting.

W. W. Swett of the U. S. Dairy Division reported in detail on matters relating to the student's dairy cattle judging contest. Replies from coaches showed that the time was not yet ripe for adding Brown Swiss to the breeds now used in this National contest. Report of this committee was adopted.

R. R. Graves of the U. S. Dairy Bureau gave an illustrated talk on the "Relationship of Conformation to Production in Dairy Cattle." The information was somewhat different than that contained in text books.

W. W. Swett, who during the past year has been conducting work on the "Measurements of Dairy Cattle," gave an illustrated lecture showing the variation in the measurements of heart girth, intestines and udder sections.

The election of officers of Section I resulted as follows: J. A. Gamble, University of Maryland, chairman; J. P. LaMaster, Clemson College, S. C., secretary.

MANUFACTURE'S SECTION

The Dairy Manufacture's Section of the American Dairy Science Association was called to order by Chairman H. W. Gregory. After reading of the minutes by Secretary Fisher, Professor Hunziker reported for the Committee on Official Methods of Testing Milk and Cream for Butterfat. The following is a summary of his report. During the past year your committee collaborated with the Referee on Dairy Products of the Association of Agricultural Chemists, the Committee on Standardization of Equipment and International Association of Milk Dealers, and preliminary work was done also dealing with an investigation of the merits of the Fucoma Test and the Hoyberg Test for milk and cream.

1. Collaboration with the A. O. A. C. Your committee cooperated with Dr. Julius Hortvet, Referee on Dairy Products of the A. O. A. C. in efforts to completely revise and bring up to

date the "Official Babcock Method" of the A. O. A. C., which became obsolete. As the result of a joint meeting held in Chicago, September 14 and 15, 1923, and later conferences and correspondence, the Referee adopted for recommendation to his association the specifications for standard glassware of the A. D. S. A. and the Bureau of Standards and drafted a new set of directions for the operation of the Babcock Test. In assembling these directions, the standard directions of the A. D. S. A. served as the basis and the final draft corresponds in all fundamentals and in most of its details with our standard directions. This revised official Babcock Method, consisting of specifications for glassware and directions for operation, was subsequently adopted by the A. O. A. C. at their annual meeting in Washington, D. C., on November 19 and 20, 1923.

Slight modifications of the standard glassware were subsequently submitted for consideration and on motion favorably acted on by the A. O. A. C., and your committee was requested to submit the same for action to the A. D. S. A.; your committee explained the objections of these modifications and recommended that our Association do not favor them.

2. Collaboration with International Association of Milk Dealers. The Committee on Standardization of Equipment, R. N. Little, Secretary of the International Milk Dealers' Association, had under control the standardization of Babcock glassware for that Association. The chairman of your committee conferred with the above committee in meetings held in Chicago, December 13, 1923 and March 4, 1924, explaining the existence, history and purpose of the standard glassware adopted by our Association and by the Bureau of Standards. After full discussion, the Committee of the International Milk Dealers' Association adopted the standard glassware of our Association and recommended plans for its more general recognition and adoption by the users of the Babcock Test.

3. Investigation of Fucoma Test and Hoyberg Test. Preliminary work was undertaken to determine the suitability of these tests under American conditions. No recommendations were offered, but it was suggested that the work be continued.

The above report with its recommendations was adopted.

Dr. E. G. Hastings, in the absence of Dr. R. S. Breed reported for the Committee on Bacteriological Methods. It was pointed out by Dr. Hastings that Dr. Breed who is chairman of the committee, also acts as referee on standard methods of milk examination for the American Public Health Association. This makes possible a program of cooperation which is very essential for unified action and progress in standardizing methods of milk analysis.

Dr. Breed as part of his report, submitted copy of his report rendered as referee of the American Public Health Association. In this report he urged the need for development of:

a. Research methods for determining the actual number of bacteria in milk, and milk products.

b. Routine and verification methods for the use of public health control laboratories in controlling market milk.

c. Routine methods for the use of industrial concerns distributing milk and milk products.

Dr. Breed further reported slow but real progress in the efforts to standardize the composition and other ingredients of standard media. Studies have shown that particularly in the case of pasteurized milk the use of various commercial brands of peptone and beef extract bring about marked variations in the resulting bacterial counts. Efforts are therefore under way to prescribe an agar medium of such definite composition that the bacterial counts obtained from the different laboratories shall be comparable. In accordance with recommendations made by Dr. Hastings and Dr. Harding it was recommended that the methylene blue reductase test be adopted as a standard method of milk analysis.

Report of the committee was accepted.

Dr. E. S. Guthrie next presented a paper on "Trier Versus Wedge Methods of Sampling Tub Butter." Dr. Guthrie in summarizing the work stated: "No one method of sampling stands out as being the most nearly accurate. Whatever method is employed it is apparent that a creameryman who manufactures butter with less than 80.5 per cent fat or more than 15.5 per cent

moisture is treading on dangerous ground." He further pointed out that there was need for further research on the problem. In the discussion that followed Professors Hunziker and Bouska brought out the practical difficulties involved in sampling cold storage butter due to the condensation of moisture.

Reporting for the Committee on Score Cards and Legal Standards, Professor J. H. Frandsen explained that although at present the committee had recommended score cards for only part of the various dairy products it had thought best to withhold further suggestions until a more complete study could be made. The committee had however devoted considerable time to a discussion of standards for ice cream and recommended the following resolution:

WHEREAS this Association recognizes the general interest existing at this time in the question of definitions and standards for ice cream, and,

WHEREAS it believes that the interest of both the consumer and the dairy industry is best served by the production of ice cream of high food value and a palatability that will tend to increase consumption:

Be it resolved that the American Dairy Science Association does not look with favor on any movement which will result in a definition or a standard permitting the use of a low fat content or of inferior materials of any nature.

The committee explained that in drafting this resolution they had in mind to express the opinion that this Association is in favor of a high quality product and the use only of high grade materials in the manufacture of ice cream. The motion was seconded and passed.

Dr. Charles North then gave a paper on "Milk Oil as an Article of Commerce." In this paper Dr. North reviewed the history of dehydration of milk with special reference to milk fat. He pointed out that milk oil is now being made on a commercial scale and expressed the opinion that this product will soon prove of great interest to the Dairy Scientist and in the near future will compel recognition by all of the main branches of the Dairy Industry.

The next number on the program was a paper by Professor

Hunziker, on "Treatment of Cream for the Removal of Objectionable Flavors and Odors." Summarizing his report, Professor Hunziker stated that the keynote to permanent improvement in the quality of American butter lies in better cream. However, in sections where herds are small, economic conditions handicap the establishment of conditions essential to the production of cream of high quality. Cream from such sections often contains off flavors such as seasonal feed and weed flavors, flavors absorbed from foreign substances, fermentation flavor, etc. Many of these flavors are volatile or volatilizable. It is possible by intense treatment to remove most of these off flavors and thereby improve the quality of butter made from such cream. The most effective treatment according to Professor Hunziker, for removing off flavors from cream for buttermaking, consists of standardizing the cream to a low and definite point of acidity; flash pasteurizing it, and spraying it into a high vacuum, then blowing heated air through a continuous spray of the hot cream while still maintaining a partial vacuum until cream is free from all removable off flavors.

To avoid danger from premature churning and mealy texture, it is necessary to keep the cream in motion until it is cooled and to cool it rapidly without excessive agitation. Professor Hunziker pointed out that while the process has been commerically successful and is in practical operation, there is further need of research and study on such factors as: the ratio of the evaporation, the behavior of individual flavors, conditions controlling their volatilization and the physical changes of the fat units.

Dr. G. E. Holm of the Bureau of Dairying, Washington, D. C., gave an illustrated lecture on "Factors Influencing the Keeping Quality of Milk Powder." He explained the relation between the absorption of oxygen and the development of tallowness in milk fat. The speaker also pointed out that their work indicated that a milk powder with a moisture content of from two per cent down to zero is much more likely to develop tallowiness than a milk powder with two and a half to three and a half per cent moisture.

The next paper presented was on "The Effect of Heat in Destroying Enzymes in Cream," by E. H. Parfitt and George

Spitzer. In their study of the effect of heat upon the inactivation of proteolytic enzymes, the holding process of pasteurization inactivated 71.07 per cent and flash pasteurization inactivated 63.57 per cent. Fresh sweet cream showed but very slight proteolytic enzyme activity while sour cream showed pronounced proteolytic enzyme activity of which 82 per cent was inactivated by holding process of pasteurization.

The evening session was called to order by Chairman Gregory. The first speaker on the program was Dr. H. A. Ruehe on "Some Factors Affecting the Quality of Ice Cream." In summarizing his paper, Dr. Ruehe stated that data accumulated thus far tends to show the following results.

1. High overruns in ice cream are more likely to cause shrinkage than low overrun.
2. Some of the so-called ripeners precipitate the casein of the ice cream mix, increasing the viscosity to the extent that under certain conditions the elasticity of the mix causes a shrinkage in the volume of the ice cream.
3. The action of the ripener does not stop with the freezing of the ice cream. An old ice cream remelted shows a flocculent curd.
4. Thawing and rehardening ice cream containing ripeners is conducive to shrinkage.

In the discussion that followed the importance of quality as a factor in the continued expansion of the ice cream industry was stressed with special reference to the quality and nature of the ingredients that go to make up the ice cream mix.

Professor J. D. Brew spoke on "Problems in Determining Milk Quality." Professor Brew urged the importance of uniformity in milk grading and milk control work and outlined how the problem has been approached in New York State and the progress made.

Professor Fisher gave a brief review of the work of the Storrs Experimental Station in regard to a "Comparative Study of Methods for Determining the Per Cent of Fat in Ice Cream" with special reference to the Fucoma method. Forty six samples of ice cream were analyzed for fat by the Mojonnier, the Fucoma and a Modified Babcock Method. The average per cent of

variation from the Mojonnier was 0.39 per cent for the Fucoma and 0.34 per cent for the Modified Babcock Method. It was pointed out that the data were of a preliminary nature and that further studies are being made with special reference to the Fucoma method as to time and speed of centrifuging, temperature of reading, the fat column, and accuracy of weighing out charge on a torsion balance as compared with the chemical balance. (This paper printed in full elsewhere in this issue.—*Editor.*)

Professor W. Fisk briefly discussed the desirability of appointing a committee to make a study of the various methods for determining the per cent of fat and total solids in ice cream and moved that such a committee be appointed to report at the next annual meeting. The motion was seconded and passed. The incoming chairman later appointed the following on this committee: R. C. Fisher, chairman; H. E. Ruehe; W. Fisk.

The report of the Committee on Rules for the National Dairy Products Judging Contest, was given by Professor H. F. Judkins, chairman of the committee. The report summarized the result of a questionnaire sent to the various colleges as to the value of the contest. All are much in favor of continuing the contest.

The results of a questionnaire as to methods of financing the expenses of the teams were presented. This part of the report indicated that in most cases activities of the various dairy clubs were responsible for the expense funds.

It was decided to hold another practice ice cream judging for coaches next year, but not to include ice cream in the products to be judged by students.

Next year we go back to the old cheese score card: 45 points for flavor, 30 for body, 15 for make-up and 10 for color. The possible criticism on the various factors in scoring all products will be placed on the score card so the student will simply check the defects he finds.

Rule 14 was changed so that no Institution having a representative acting as superintendent of the butter or cheese exhibit can enter a team in the contest. A committee of two judges for each product is to be chosen in advance by the superintendent

of the contest and each college is to be notified as to the membership of this committee.

Report of committee adopted.

Election of officers of Section II resulted as follows: H. F. Judkins, Amherst, Mass., chairman; N. A. Olson, Manhattan, Kans., secretary.

The meeting was then adjourned until 1925.

OFFICIAL TESTING SECTION

The Annual Meeting of the Official Testing Section of the American Dairy Science Association was held in Milwaukee, September 29, 1924.

The meeting was presided over by R. T. Harris of the University of Wisconsin, chairman of the Section. About fifty were present representing twenty-two states; also, the secretary of the Ayrshire Breeders' Association and the president of the American Jersey Cattle Club were in attendance.

A paper sent in by A. Folger of the University of California on the Foot-and-Mouth Disease in California was read. The disease interrupted the Advanced Registry work very considerably for several weeks but through the cooperation of the breeders, the Breed Associations and the test supervisors, who took unusual precautions, the work did not seriously suffer.

M. H. Campbell of the University of Illinois described his method of handling check tests. This paper will be sent in full with the secretary's report to the several State Superintendents.

E. L. Anthony of the University of Illinois gave an interesting talk on the use of records for dairy cattle in Europe. He pointed out that about 24 per cent of all cattle in Denmark are on test during their lifetime work. Cows, to be admitted to the Record Registry, must have completed three successful yearly records.

The question of breeders in some states demanding recognition of Cow Testing Association testers was raised. In the discussion which followed it was emphasized that the primary purpose of a cow test record is to single out the good and poor workers in a herd while the Advanced Registry throws light upon the great producing and reproducing individuals. There is so

much at stake in the latter records that a cow tester, in the employ of the breeders themselves, is not in a fair position to conduct Advanced Registry test for members of his testing association.

H. N. Colman of Oregon Agricultural College discussed special problems and tendencies in the Western Section. He stated that the coast states at least have divorced Cow Testing Association and Advanced Registry and that the American Dairy Science Association rules he believed were in force in all of the Rocky Mountain states.

G. C. White, chairman of the Breed Relations Committee, was then called upon for a committee report. The deliberations of this committee at its meeting the previous day at which all but one member were present and at which meeting also was Mr. Kyle of the Ayrshire Breeders' Association and Mr. and Mrs. Gardner of the Holstein-Friesian Association were briefly outlined.

The committee recommended the adoption of the revised rules for the guidance of the supervisor as presented by J. R. Dice of North Dakota Agricultural College and J. B. Fitch of Kansas Agricultural College. Slight revisions were made to clarify the rules and to have them include the actions of the Official Testing Section at its two previous meetings. With slight changes they were adopted by the Section and they follow in full below.

Rules for the guidance of the supervisor in the conduct of official tests

1. Rules must be followed. The supervisor is not at liberty to decide as to which stipulations contained herein are essential and which are not, but is required to observe these directions in all details.

2. Relationship of supervisor. The supervisor shall bear in mind at all times that he is the representative of the State College or Experiment Station and the Breed Association and is not working for or taking directions from the breeder, and his duty is to see that the test is honestly made and accurately reported.

3. Identification of animal. The supervisor shall study the registration papers or official diagrams of each cow carefully and be sure that the cow he is testing is the animal to which the registration papers belong. Because of the difficulty of identification, each cow not having

a distinctive marking must bear a tattoo mark in the ear. This mark must be recorded on the official report or the test is worthless. Unidentified cows are allowed to be placed on test, but whenever the registration papers are not at hand, a sketch must be made of the color markings and a statement made on the report as to why it was necessary to enclose the sketch. This is also necessary when the color markings do not correspond with the registration papers.

4. Possessor considered owner. For all purposes of Official Testing work, the possessor is considered the owner and is required to treat the animal as such, presenting all necessary data, the same as for his own.

5. Number of milkings to be supervised at one time. No supervisor is allowed to supervise more than twenty-four (24) milkings per day without special permission from the State Superintendent of Official Testing, unless all cows under test are milked twice daily, when a limit of thirty (30) milkings is permissible.

6. Preliminary milkings. All tests require a preliminary milking. In taking a preliminary milking, the supervisor shall make certain the cow is milked dry. The exact time that this milking is made should be recorded in the barn book. The last milking of the test shall be made neither earlier nor later than the time of the preliminary milking. All preliminary milkings shall be weighed, tested and reported.

7. Rules for conducting the test:

Before each milking period, the supervisor shall observe that the milk pail is clean and dry and shall carry the milk pail at all times during the milking period, allowing the pail out of his hands only during the actual milking process.

Only one cow shall be milked at a time, and the supervisor must in every case be in a position to observe the milker during the entire milking process.

Milking machines: Where a milking machine is used only one cow shall be milked at a time and no second man as a stripper is allowed. Milking machine is to be let run idle for a few minutes before attaching to the cow to insure that no milk is coming from another source.

Right of search: The supervisor has the right to search the milker at any time and require milkers to roll sleeves up to the elbows. Refusal on the part of the milker will be construed as evidence of intent to make a fraudulent test. In case of retest or verification test the supervisor shall search the milker.

Weighing milk: The supervisor shall weigh the empty pail before

each milking. Immediately after each milking is completed he shall take charge of the pail and weigh the same on scales provided by the College and enter the exact weight of the milk at once in his barn book, and see to it that the milker records the same weight on the owner's barn milk sheet. Any inaccuracy in the owner's scales shall be reported to the superintendent in the state concerned and to the Breed Association.

Sampling milk: The supervisor shall take a sample of the milk of each milking immediately upon the weighing of the milk, being careful that the milk is thoroughly mixed. Such samples shall be kept under lock and key or in the supervisor's sight until the samples have cooled to ordinary room temperature, which is 60° to 70°F. When the last samples at night are kept until morning, unless thoroughly cooled in warm weather, preservative should be added to each sample. These cooled samples shall be warmed to 70°F. before samples are taken for testing.

Applying the Babcock test: The fat determination shall always be made in duplicate, and both determinations recorded. The average must be used in computing the amount of fat. Readings of the tests shall be made at a temperature of 130–140°F. This temperature to be obtained by placing the bottles in a hot water bath for 5 minutes. If the duplicate determinations vary more than 0.2 of one per cent the test must be repeated. The samples taken at any one milking shall not be thrown away until satisfactory duplicate tests of the milking are obtained.

8. Lost milk and lost samples. No substitution of lost milkings or lost samples is allowed. Any missing data due to loss of milk weights or test samples are to be left blank on the report.

9. Preliminary reports. The supervisor shall report to the Superintendent of Official Testing any obvious violations of the rules of the College or the Breed Associations on the part of the owner or attendants, and shall report immediately any cows that meet retest requirements and note upon his report form any sickness of a cow or other condition likely to affect the reliability of the test.

A preliminary report card shall be mailed by the supervisor from the farm to the Breed Association immediately after the test. Any cow not in normal condition should be reported on this card.

10. Reports. The supervisor shall make out his reports so as to give all of the information asked for and then sign and mail them promptly to his appointing officer for checking and endorsement.

11. Test periods exceeding two days. Where a test is conducted

longer than the regular two days, or where more than one test is made in a month, all details of each test from beginning to end shall be reported.

12. Payment of supervisors. Under no circumstances shall any payment, gift or gratuity to the supervisor be made by, or permitted from the owner of the cow or anyone interested in her, and any violation of this rule will invalidate the test.

13. Supervisors to supervise tests. The supervisor appointed to conduct a test is the direct representative of the Superintendent of Official Testing and should be respected accordingly. His duties are to supervise tests only.

14. Sworn statements. Each supervisor is required to fill out a sworn statement covering all his work, which eliminates the necessity of his affirming test reports.

15. Responsibility for enforcement of rules. Owners and persons in their employ are held equally responsible with the supervisor for the enforcement of the foregoing rules. Test reports will not be accepted unless all of the above rules have been observed by all parties concerned.

G. E. Morton of Colorado Agricultural College spoke about having the supervisor take oath. It was pointed out that the common practise in most states is to have the supervisor take oath when he takes up his work or as in other states to take oath once each month covering all the work for that month.

Chairman White then reported on the meeting of a sub-committee of the Breed Relations Committee which had been instructed to interview the American Jersey Cattle Club with reference to the enforcement of the preliminary milking rule. O. E. Reed of Michigan Agricultural College, R. T. Harris of the University of Wisconsin, C. E. Wylie of the University of Tennessee and G. E. White of the Connecticut Agricultural College comprised the committee. This committee had a session with Mr. M. D. Munn and Mr. O. H. Baker of the American Jersey Cattle Club.

Mr. Munn assured the committee that they wanted to place all necessary safeguards around their tests. The committee told him there seemed to be sufficient evidence now on the value of the preliminary milking: for setting a time of beginning the test to prevent or discourage padding milk weights; and to prevent or

discourage leaving strippings in the udder which both raises the test and the milk yield during the test. Mr. Baker stated that they could detect this practise with their checking system. The committee then proposed that the Jersey Club should take the entire responsibility for this matter and preliminary milkings on Jerseys should be discontinued everywhere. Messrs. Munn and Baker then stated that the whole matter would be placed before their Board and that they would make every effort to come to a satisfactory settlement of the whole matter at an early date.

After considerable discussion, the Breed Relations Committee was authorized to continue negotiations with the American Jersey Club until a satisfactory settlement is reached, the matter to be reported back at the next meeting.

Election of officers of Section IV for the ensuing year resulted in the selection of G. C. White, Storrs, Conn., chairman; C. E. Wylie, Knoxville, Tenn., secretary.

The following committees have been appointed by the chairman:

Breed Relations Committee: W. M. Regan, Calif.; J. B. Fitch, Kans.; A. A. Borland, Penn.; J. R. Dice, N. D.; M. H. Campbell, Ill.; O. E. Reed, Mich.; C. E. Wylie, Tenn., chairman.

Investigation Committee: R. T. Harris, Wis., chairman; H. N. Colman, Ore.; J. S. Peterson, Minn.; A. R. Darnell, Texas.

Signed: G. C. WHITE,
Secretary.

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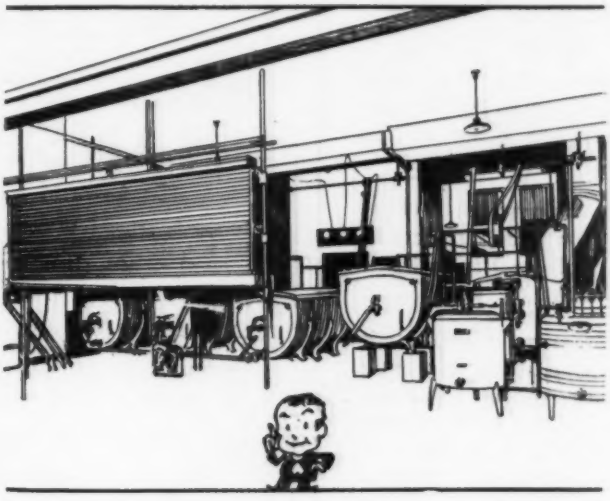
Gold medal for highest individual all products, by National Dairy Exposition.....Werner W. Griese, Iowa State College
Silver medal (second).....Roy O. Storvick, Iowa State College
Bronze medal (third).....Truman D. Romig, Ohio State University
Gold medal for highest individual in butter.
American Creamery Butter Manufacturers Association.....Roy O. Storvick, Iowa State College
Silver medal for second highest individual in butter N. D. E.....Fern T. Moore, Iowa State College
Bronze medal for third highest individual in butter, N. D. E.....Werner W. Griese, Iowa State College
Gold medal for highest individual in cheese
National Cheese Association.....F. H. Cherry, Purdue University
Silver medal for second highest individual in cheese, N. D. E.....Pierce Thompson, University of California
Bronze medal for third highest in cheese, N. D. E.....Chas. H. Gough, Pennsylvania State
Gold medal for highest individual in milk.
International Milk Dealers Association..Werner W. Griese, Iowa State College
Silver medal for second highest in milk, N. D. E.....P. J. Davenport, Massachusetts Agricultural College
Bronze medal for third individual in milk, N. D. E.....Leland L. Currier, Massachusetts Agricultural College



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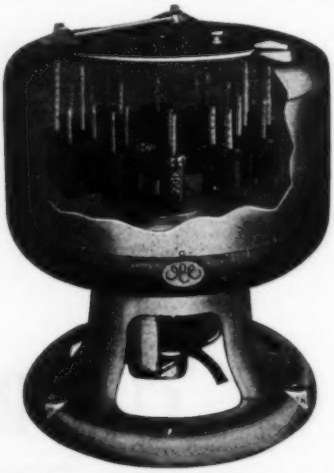

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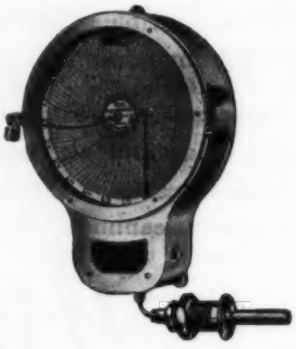

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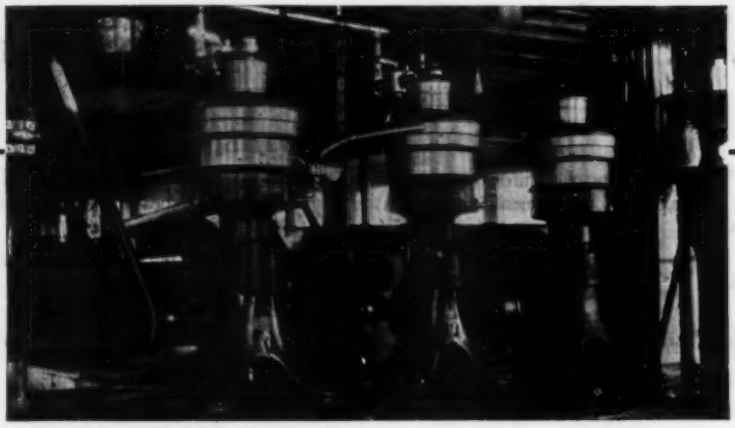

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